ECONOMIC IMPORTANCE OF ESRPA-DEPENDANT SPRINGFLOW TO THE ECONOMY OF IDAHO

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EXHIBIT
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Burley Irrigation District
American Falls Reservoir District
Milner Irrigation District
Minidoka Irrigation District

DISCLAIMER

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It should also be noted (since the author of this report is a retired professor at the University of Idaho) that this report is not a work product of the University of Idaho and does not necessarily represent positions or views of the University of Idaho.

EXECUTIVE SUMMARY

Idaho is presently facing some difficult policy decisions about water allocation and use. In south-central and south-east Idaho the focus is on conjunctive use of groundwater, surface water and springflow. The purpose of this report is to shed light on one big part of that policy puzzle by documenting the importance of aquifer-dependant springflows to the Idaho economy.

The Eastern Snake River Plain is notable because of the unusually close linkage between the Snake River and the underlying Eastern Snake River Plain Aquifer (ESRPA). The relationship between the river and the aquifer varies by reach, and has varied through time. Springflows initially increased, starting in the late 1800s, as abundant applications of surface water to newly irrigated land recharged the aquifer. By the 1950s springflows peaked and began to decline, as the efficiency of irrigation water conveyance and application systems improved, and as deep well pumping of irrigation water became feasible. Simulation runs of the new ESRPA model document that groundwater pumping alone accounts for spring flow declines of 649 kaf (649,000 acre feet or 897 cfs) above Blackfoot, 888 kaf (1226 cfs) between Blackfoot and Milner, and 473 kaf (653 cfs) in the Thousand Springs reach for a total of 2.01 maf (2.01 million acre feet or 2776 cfs). Given these changes, the present situation is as follows: above Blackfoot the river loses water to the aquifer, between Blackfoot and Milner springs contribute about 1.63 maf back to the river, in the Thousand Springs area spring flows account for 4.1 maf gain in that reach of the river.

The value of production from ESPA spring water-dependent industries is at least $600 million, and probably far more. But, the declines identified above have also had significant adverse economic impacts on spring flow users. Irrigators in each of these three river reaches have suffered some loss in crop production because they have not had enough irrigation water. This report documents that groundwater pumping caused damages to spring-dependant irrigation that sum to as much as $260 million per year in crop value They have also incurred additional costs to make their water delivery and application systems more efficient so they could get by with less water. An unintended consequence of these efficiency improvements has been a further reduction in aquifer recharge, with cascading effects lower down in the ESRPA. Any water that is not consumptively used in the region flows through a series of hydropower plants as it flows to the ocean. Spring flow declines attributed to groundwater pumping have significantly reduced the electricity that can be generated by Idaho Power Company and the downstream federal dams. Damages to spring-dependant hydropower approach $100 million per year in electricity value, potentially increasing the rates that Idaho electricity consumers must pay. Other spring water users have also been affected by reduced water flows. Aquaculture in the Thousand Springs reach has been damaged by decreased production capacity and diminished ability to take advantage of aquaculture production technology advances. Other sectors already damaged by springflow declines include recreation and tourism, and endangered species recovery. Damages to these sectors, while real enough, and significantly large, are much harder to attach a dollar value to, in part because the necessary data is not available. If not for the loss of water incurred by senior water right holders, the spring flow-dependent industries could be contributing at least $1 billion to Idaho's economy.

It is important to recognize that the economic effects of springwater shortages have already been felt in the southern Idaho economy. These effects are presently impacting senior springwater users, rather than junior groundwater users, who continue to pump unimpeded. The total impact on southern Idaho's economy of following the priority doctrine and shifting the impacts back to the junior users should not be large, since many of the effects are already accounted for in the local economy.

While it might be tempting to try to extend the results of this report to try to draw conclusions about the benefits and costs of a curtailment scenario, it is probably premature to do so. No curtailment scenario has yet been well fleshed out – who it would apply to, how it would be implemented, and who would pay for it. We as yet have no models to show how the curtailed junior appropriators who farm or those irrigators who remain would respond. We do not know how many junior appropriators also have senior water rights either for surface water or for ground water. We don't have models to show how springwater users would respond to restored flows. We don't have models that can show how these changes in production patterns translate into changes in income, and into fiscal impacts for the state budget. These models would be valuable in assessing the probable impact of out-of-priority curtailment, and the impact of any proposed curtailment or mitigation plans.

The following tabulation shows the economic impacts of springflow, by sector. Where possible, dollar values of output are shown, both for the total impact of springflow, and for the impact of changes in springflow caused by groundwater pumping.

<u>Irrigation in the reach above Blackfoot</u>

This reach of Snake River loses 467 kaf to the ESRPA, so it is not possible to identify particular lands in this reach as springflow-dependant. However, groundwater pumping has increased reach

Economic Importance of ESRPA-Dependant Springflow

losses by 649 kaf, reducing natural flow supplies to irrigators in this reach and reducing storage refill downstream at American Falls. If half of this water that is summer flow had been used for irrigation in this reach, it could have produced crops valued at $36 million.

Irrigation using American Falls springs

As much as 56 percent of the flow and storage water supply for irrigation diverting from the American Falls to Milner reach depends on 1.6 maf springwater from the ESRPA. The value of the crops grown with this water is about $181 million. Groundwater pumping has reduced springflows in this reach of the Snake River by 888 kaf. Adding in the storage of water from springs above Blackfoot, the total impact of groundwater pumping has been to reduce water supplies available at American Falls by about 1.2 maf. The absence of this water has caused some crop losses in this reach, but more importantly it has prompted farmers and water delivery organizations to make delivery system changes and changes to irrigation practices. These changes have been costly, and have reduced recharge to the lower ESRPA, causing further problems. If half this 1.2 maf could have been used for irrigation in this reach, it could have produced crops valued at $133 million

Irrigation using Thousand Springs water

About 5,500 acres near Hagerman use flow directly from springs, producing $2.75 million in crop value. Another 177,500 acres downstream pump mostly spring water from the river, producing crops valued at $88.75 million. Flow declines in this reach of 473 kaf are attributable to groundwater pumping. These declines have damaged the water supplies of the 5,500 acres that depend directly on springflow. Some of these damages have been mitigated by actions of the groundwater pumpers, and some of the damages continue. The high-lift river pumpers downstream have so far had plenty of water, although they are suffering from high power costs and are approaching curtailment because the 3,900 cfs minimum stream flow mandated by the Swan Falls Agreement has nearly been reached.

Aquaculture at Thousand Springs

The Thousand Springs reach is a world center for rainbow trout production and processing. Product export value is about $79 million. Substantial additional recreational value is created at non-commercial fish farms with budgets totaling at least $7 million. Reductions in springflow to the commercial fish farms result in a proportional loss of export value. Groundwater pumping has reduced water supplies to many of the fish farms well below their decreed rights, and has imposed continuing costs on the industry.

Hydropower using springflow

An acre-foot of water in American Falls Reservoir could potentially generate 1,953 kwh of electricity worth $87.89 at 22 downstream IPC and federal hydropower plants. The 3.7 maf of Thousand Springs water not consumed for irrigation can generate electricity worth $240 million per year ($136 million at IPC dams and $104 million at federal powerplants). The 473 kaf reduction in Thousand Springs flow attributable to groundwater pumping could have generated power valued at $30.3 million ($17.2 and $13.1 million at IPC and federal dams). Similarly, the 1.5 maf reduction in reach gains above Milner due to groundwater pumping, about half might otherwise have flowed downstream generating $66 million worth of electricity ($45 million at IPC dams and $21 million at federal dams). Additional hydropower value is generated by hydropower plants at the springs, and within the systems that deliver irrigation water, and production at these powerplants has been damaged as flows have dropped below design capacity.

Economic Importance of ESRPA-Dependant Springflow

DCMI users of springflow

The city of Twin Falls uses Blue Lakes water which originates from the ESRPA, but springflows have fallen due in part to groundwater pumping. Twin Falls is increasing its use of well water, which originates from American Falls springflow recharged into the local south side aquifer. The feasibility of substituting well water for Blue Lakes water is limited by water quality issues. Responses to irrigation water supply shortages in the Twin Falls Canal Company are likely to cause water table declines, jeopardizing municipal well yields.

Recreation users of springflow

Amenities linked to springflow are used for fishing, boating, sightseeing, camping, and hunting. Spending on these activities forms a significant part of the local economy, especially in the Thousand Springs reach, and is vulnerable to springflow declines.

Environment & endangered species concerns.

Several threatened or endangered mollusks are jeopardized by low water flows in the Thousand Springs reach. Down-stream flows for endangered salmon may be jeopardized by springflow declines.

The other side of the story consists of the groundwater users who pump from the ESRPA. The new ESRPA model estimates that groundwater irrigators pump 2 million acre-feet, and apply this water to 1.1 million acres.

Junior groundwater users

Of the 1.1 million acres, 989,389 acres are junior to a 1/1/1949 priority date, 663,284 acres are junior to 1/1/1961 priority date, 375,861 acres are junior to 1/1/1973 priority date and 77,383 acres are junior to 1/1/1985 priority date. This groundwater-dependant land presently grows crops valued at about $550 million. Any plan to curtail junior groundwater pumpers would have to specify a priority cutoff date. This cutoff might differ by region – for example Twin Falls and North Side Canal Companies are senior to almost all wells that might influence their supplies, while spring water users in the Thousand Springs area have priority dates ranging from the 1880s to the 1980s. Curtailment scenarios are still being debated by the affected parties but if groundwater users are curtailed, then the crop mix of remaining farms is likely to adjust to use the available land for higher valued crops and to meet needs of dairies, which would reduce the total economic impact of junior water right holder curtailment.

Senior Irrigation and DCMI groundwater users

Senior groundwater users (rural residential, municipal and irrigation) have suffered from increased costs to pump from the declining water table, costs of pump modification, and costs of declining well yields.

Dairies using groundwater

Many dairies have junior water rights that could be shut off by a water call. However their water use is relatively small and many dairies can transfer water rights from crop use to dairy use. If land presently producing feed or land used for manure disposal is shut down by a water call, these functions will probably shift to other land. While these adjustments will have costs, there is likely to be little reduction in milk production.

PURPOSE OF THIS REPORT

Much of the recent media discussion of water problems in southern Idaho has cast the issue as pitting a few trout farms in the Thousand Springs reach of the Snake River against a number of large dairy operations and the thousands of acres of groundwater irrigated cropland that grow the hay and corn silage needed by the dairies. This miscasts the issue, taking a much too narrow view of how springflows are woven into the hydrology and economy of the Snake River Basin.

This appears to be a unique moment in the history of Idaho water, when water users, legislators, and the wider public are discussing the possibility of making major changes in how the state's water is allocated and used. Themes of this discussion include a possible reconsideration of the rules governing conjunctive use of ground and surface water; the possible role of artificial aquifer recharge; the possibility of relying more on markets to allocate water; and growing demands for water for domestic, commercial, municipal, industrial, recreational, environmental, and endangered species uses. The issue bringing things to a head at this time is a discussion of possible methods and consequences of curtailing groundwater users who hold water rights that are junior to but impact the water supplies of other water users in the Snake River Basin.

Regardless of how the state elects to manage the ESPA resource, it is important that everyone concerned keep in mind the "big picture", and not get distracted by the narrower issues. Because of the pervasive effects that springflows from the Eastern Snake River Plain Aquifer (ESRPA) play in the hydrology of the Upper Snake River Basin, an understanding of these springflows is an essential part of this big picture. The purpose of this report is to document this big picture view of how springflows fit into the hydrology of the Eastern Snake River Basin and the economy of all of Idaho. To a lesser extent this report provides insight regarding potential impact of curtailment on junior ground water right holders that rely on the ESPA and on the curtailment that senior water right holders have already experienced because of out-of-priority diversions.

AN OVERVIEW OF HYDROLOGY AND WATER USE IN THE UPPER SNAKE RIVER BASIN

The ESRPA is one of the largest aquifer systems in the world. It is unusual among aquifer systems because of the closeness of the linkages between the ESRPA and the Snake River. These links between aquifer and river are concentrated in three reaches (Figures 1 and 2). There are two major spring systems, springs in the area near American Falls Reservoir that contribute about 1.6 million acre-feet (maf) of reach gain to the river, and springs in the Thousand Springs reach which contribute about 4.1 maf. These numbers, based on the 1980 – 2002 calibration period used in the new ESRPA model (Contor, et al, "No Changes Scenario", 2004) are shown in Table 1. The upper Snake River above Blackfoot is also closely linked to the aquifer -- in some parts of this reach the river gains flows from the aquifer, and in other areas the river loses water to the aquifer. Tallying up the gains and losses, this upper Snake River reach is a net losing reach, recharging 467 thousand acre-feet (kaf) on average back to the aquifer.

Irrigation began in the eastern part of the Upper Snake River Basin starting in the 1870s. Most of this early irrigation was located above present day American Falls Reservoir (Figure 1). Using furrow and flood irrigation techniques, the water diverted per acre was very high by modern

Economic Importance of ESRPA-Dependant Springflow

Table 1: Reach Gains & Losses by River Reach

	Modeled Average Reach Gain for Calibration Period	
	(cfs)	(kaf)
Ashton - Rexburg	205	148
Heise - Shelly	-490	-355
Shelly - Blackfoot	-360	-261
Total Above Blackfoot	-645	-467
Blackfoot - Neeley	2,222	1,609
Neeley - Minidoka	28	20
Total Blackfoot - Minidoka	2,250	1,629
Devil's Washbowl - Buhl	969	702
Buhl - Thousand Springs	1,578	1,142
Thousand Springs	1,760	1,274
Thousand Springs - Malad	77	56
Malad	1,191	862
Malad - Bancroft	100	72
Total Thousand Springs Reaches	5,675	4,109

Source: Contor, et al, "No Changes Scenario", Table 2, 2004

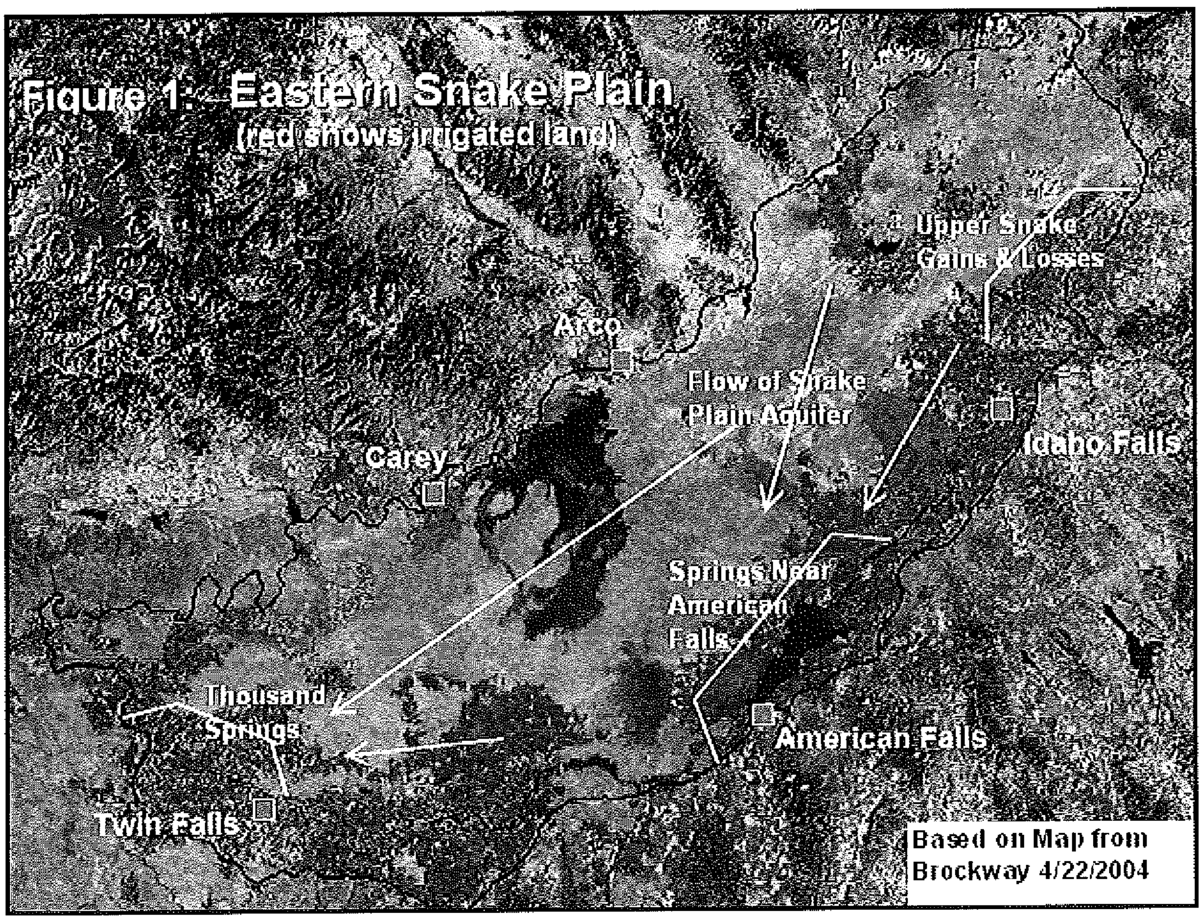
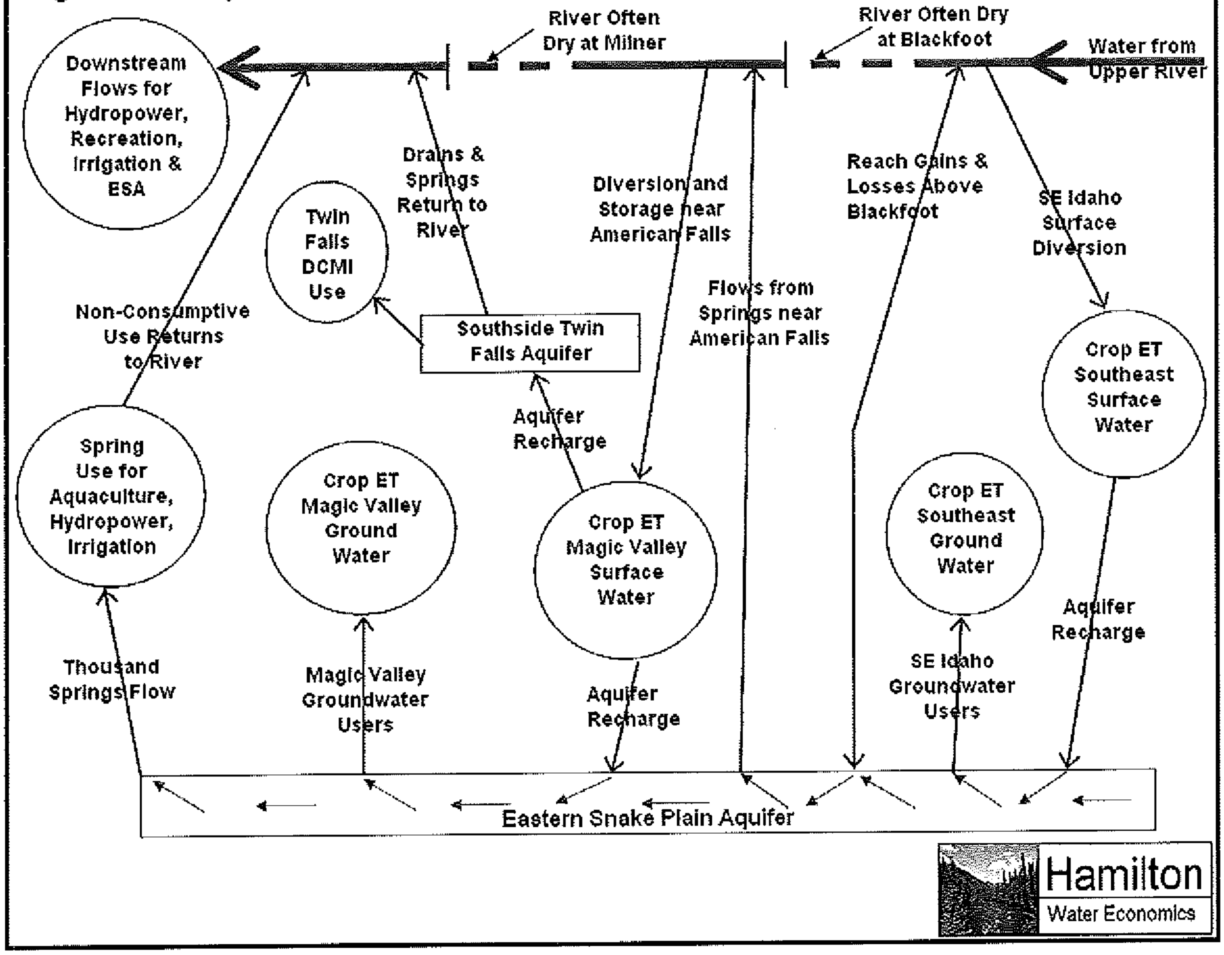


Figure 2: Simplified Schematic of Water Use in the Upper Snake River Basin



standards, but the diversions in excess of crop consumptive water use served to recharge the underlying aquifer (Figure 2).

By the early 1900s irrigation diversions dried up the summer natural flow of the Snake River at Blackfoot in many years (USGS, 2003). Thus, at the turn of the last century when the Twin Falls Canal Company and the North Side Canal Company were proposed as Carey Act projects, they had to rely on water supplies based on storage and springflow. In most years, springflows and reach gains between Blackfoot and American Falls comprise most of the natural flow rights delivered to these projects. Part of the storage that serves these projects is located upstream in Jackson and Palisades Reservoirs where it is refilled using winter flows. A larger part of their storage rights are located in American Falls Reservoir, where they are refilled largely by winter springflows and reach gains, but also by natural flows in some good water years. Several other irrigation districts in the Magic Valley and lands to the east (the Milner and Minidoka projects, etc.) have similar water rights. Thus, as illustrated in Figure 2 and Table 2, there is a large block of irrigated land – about two-thirds of a million acres mostly in the Magic Valley – that depends critically on springflows for their water supplies.

Starting in the early 1900s, these two-thirds of a million irrigated acres became very important to the behavior of the ESRPA. Irrigation diversions in excess of crop consumptive use became very significant sources of recharge to both the ESRPA and the more localized Twin Falls area aquifer. At

Economic Importance of ESRPA-Dependant Springflow

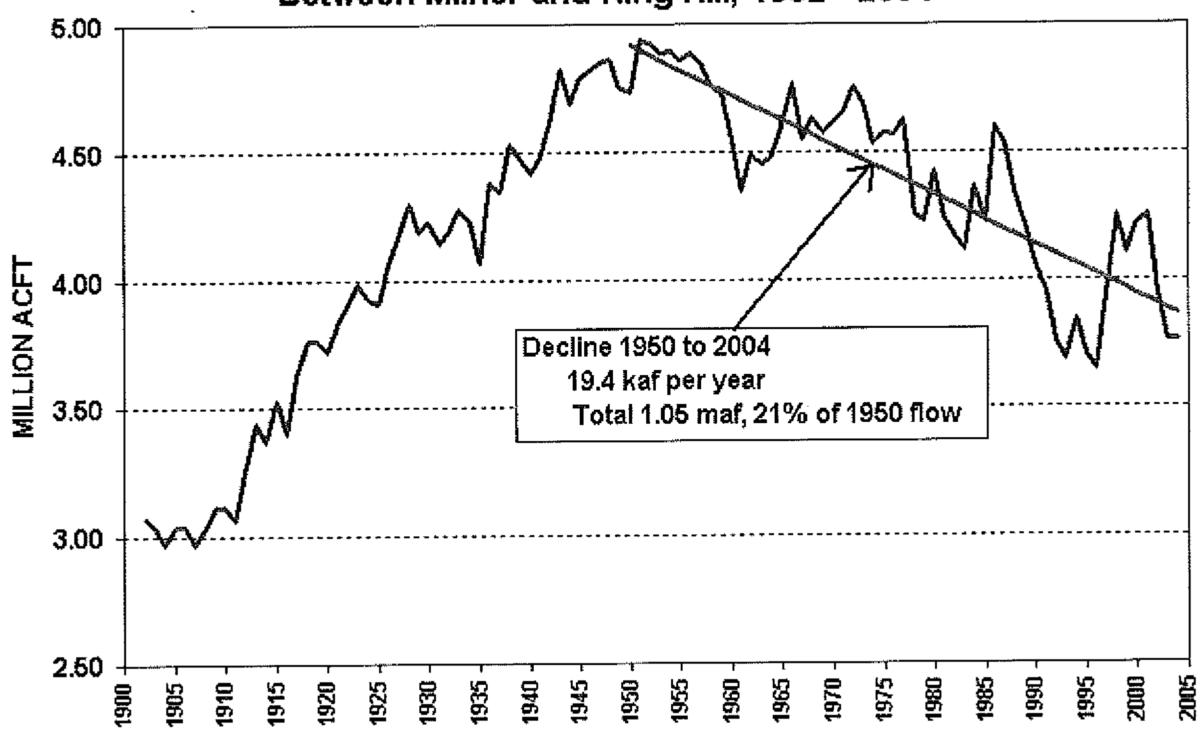
Thousand Springs, where the ESRPA spills out of the canyon wall into the Snake River, all of this aquifer recharge pushed springflows and reach gains to a peak in about 1950. Figure 3 shows the general pattern of changing springflows in the Thousand Springs reach, although the estimated flow numbers for the early years taken from the work of Kjelstrom (1995) remain quite uncertain.

Table 2: Project Irrigated Acreage for Snake River American Falls to Milner

Project:	Acres:
Minidoka	76,860
Burley	48,000
A & B	16,000
Milner Irrigation	13,548
TFCC	202,690
NSCC	162,146
American Falls Reservoir District	62,000
Falls Irrigation District	7,690
Aberdeen - Springfield	58,943
	647,877

Source: Brockway Engineering, 2004

Figure 3: Average Annual Spring Discharge to Snake River Between Milner and King Hill, 1902 - 2004



Notes:
Numbers are from USGS, using Kjelstrom method.
Number for 2004 is estimated

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Economic Importance of ESRPA-Dependant Springflow

Also in the early 1900s small amounts of springflow in Thousand Springs reach were diverted for irrigation use in the canyon. By 1912 the Thousand Springs Power Company had begun producing hydroelectric power from the springs. The first filings for aquaculture use occurred in the 1930's but it was not until the 1950s and 1960s that water rights for the developing aquaculture industry began to take a significant part of the springflow in the Thousand Springs reach.

On the south side of the river, the local Twin Falls aquifer was also recharged by deep percolation from irrigation – primarily from the Twin Falls project. Water levels in this aquifer increased by as much as 300 feet (Cosgrove, 1997) as a result of this recharge. The City of Twin Falls presently gets much of its water by pumping from the Blue Lakes area in the bottom of the canyon (water that originates from ESRPA springflows on the north side). The city also has six wells drawing water from the south side aquifer. The city views both the ESRPA and the local southside aquifer as essential water sources to meet future needs. Many other DCMI wells also tap the southside aquifer. Drainage and springs from the southside aquifer also contribute to downriver instream flows.

Beginning in the 1950s springflows at both Thousand Springs (Figure 3) and American Falls reached a peak and began to decline. At the same time water levels in the ESRPA were observed to decline. Figure 4 shows the decline observed between 1980 and 2002. Substantial additional declines have occurred since 2002. There are at least three reasons (not prioritized) for this aquifer and springflow decline, (1) changes in irrigation practices and technology that result in less recharge, (2) variations in weather, and (3) consumptive depletion by irrigation pumping from the aquifer.

Box 1: Externalities

Economic externalities occur when one person's actions affect other people, but the first person doesn't have to take account of these effects in his decision-making process. All the hydrologic linkages between the ESRPA and the Snake River mean that nearly every action by a water user produces some kind of externality affecting other water users.

For example, irrigators almost always apply more water than is consumptively used by the crop, and at least some of the excess seeps down to recharge the aquifer. These farmers are producing an unintended positive externality of groundwater that can serve as someone else's water supply. If the farmer installs sprinklers, this reduces the positive externality.

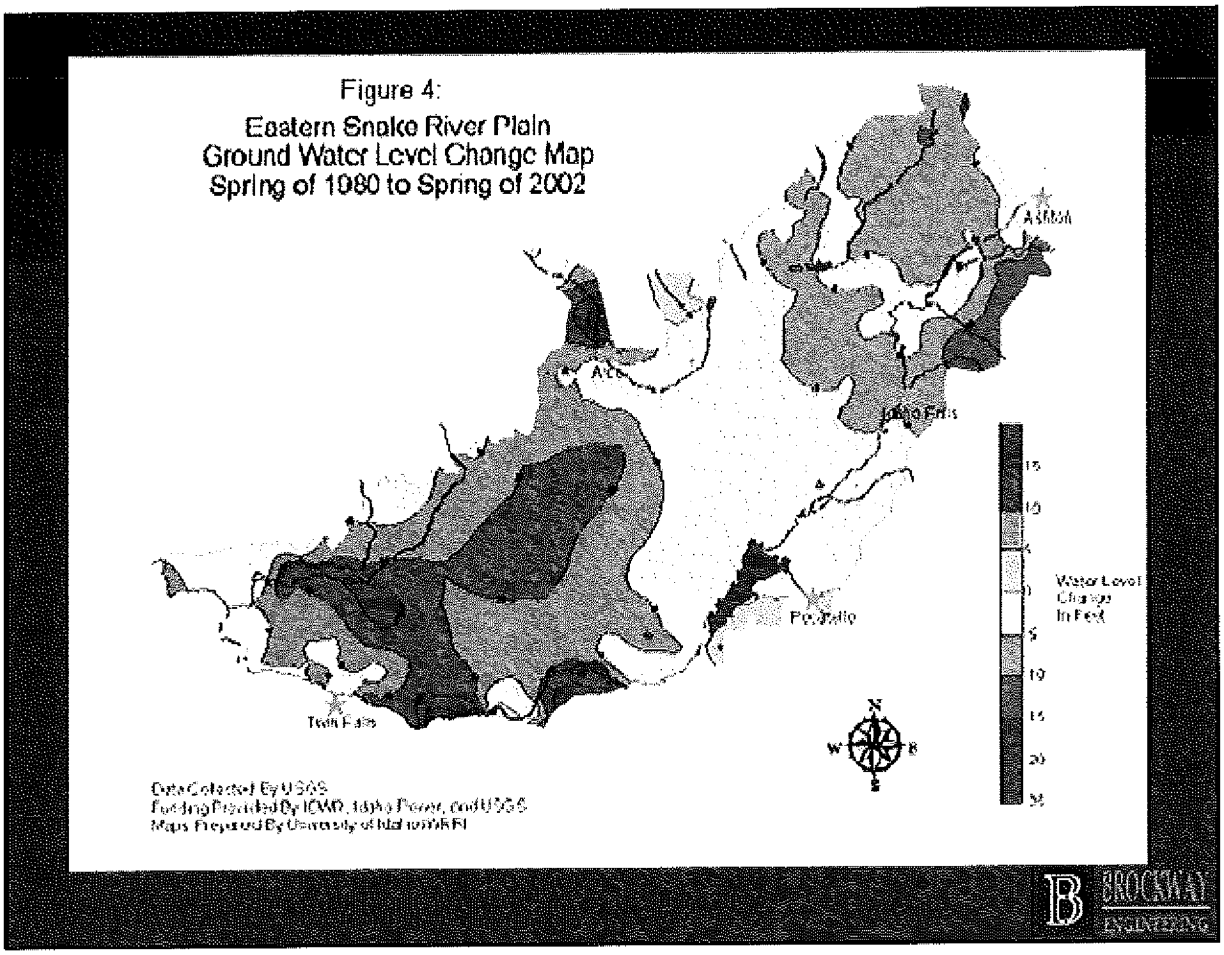
Another example – a groundwater pumper produces the unintended effect of reduced springflow, a negative externality felt by users of that springwater.

Externalities often cascade down-gradient in a hydrologic system. An irrigator pumping groundwater from the ESRPA causes the negative externality of reduced springflows in the Twin Falls reach. The Magic Valley farmers relying on these springs for their water supply respond to the reduced flows by lining canals and installing sprinklers, producing another negative externality of reduced aquifer recharge, and reduced springs flows. The City of Twin Falls responds to reduced Blue Lakes springflows and reduced well yields by drilling more wells, producing more negative externalities for other DCMI users relying on the same aquifer water.

This cascade of externalities down the hydrologic system, based on hydrologic linkages and human responses tends to magnify the effect of the initial action. For that reason, the new ESRPA model, which looks only at the physical water linkages but not at the human responses, may underestimate the total effects of water policy decisions.

Economic Importance of ESRPA-Dependant Springflow

Irrigation practices and technology have changed greatly in the more than 100-year history of irrigation in Idaho. The biggest change has been conversion from gravity application methods to sprinklers, but innovations such as canal lining, laser leveling, elimination of winter canal flows for livestock use, and irrigation scheduling have also contributed. Each of these has improved the efficiency with which diverted water is supplied to meet crop needs, and as a consequence has reduced the deep percolation that previously recharged the aquifers. These practices are still far from universally adopted, so there is a large potential for future efficiency increases to further reduce aquifer recharge.

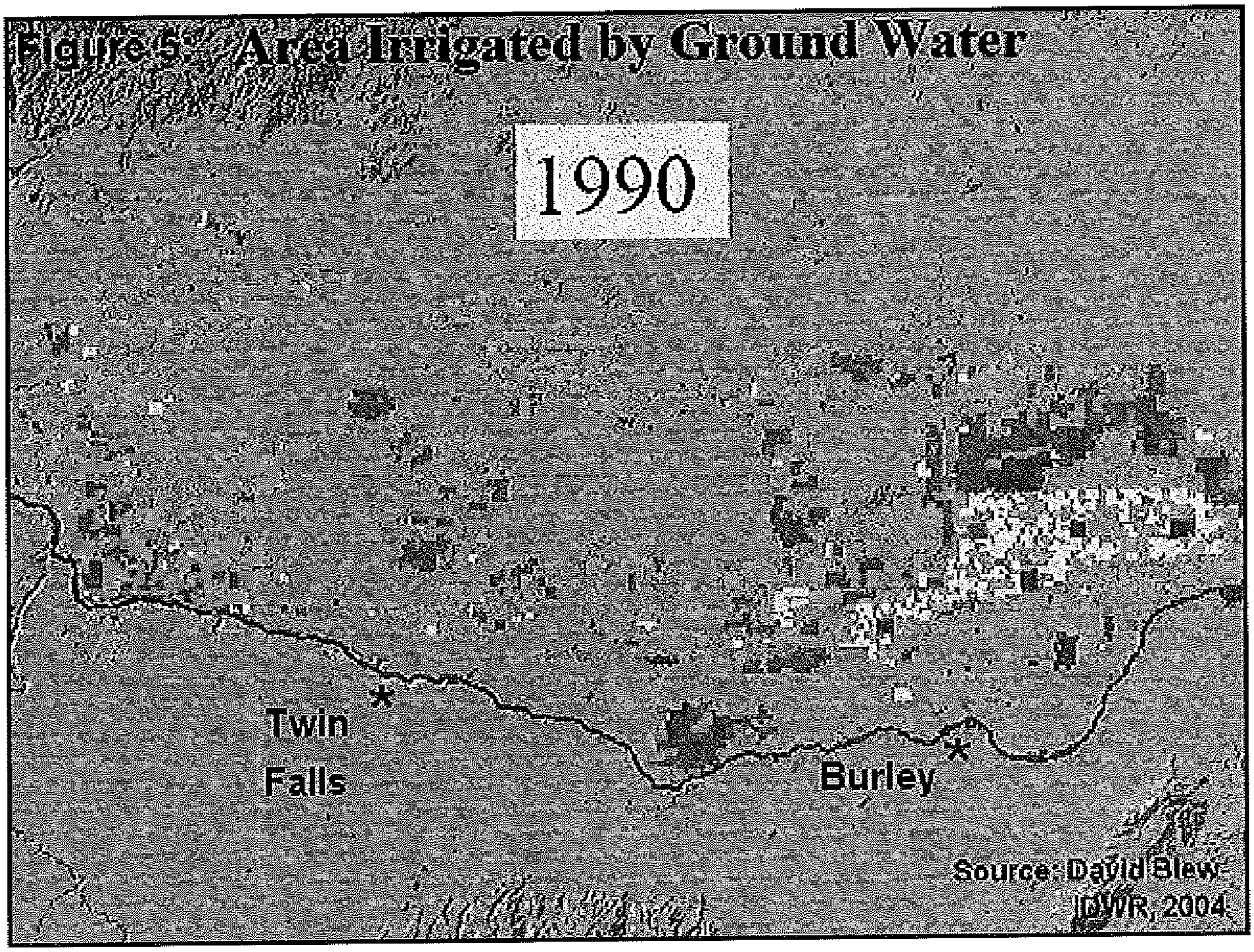


Weather variations clearly do have an effect on springflows. Inflows from peripheral watersheds and local precipitation on cropland both have effects. The current drought (2000-2004) is one of the causes of recently observed declines in springflow. However, apart from the possible water supply impacts of global climate change, the effects of weather should be transient (Brockway, personal communication).

Significant irrigation relying on groundwater pumping began in the 1950s, based on advances in deep well pumping technology. New diversions of groundwater for irrigation continued until very recently. The Idaho Department of Water Resources documents 13,700 new wells (slightly less than 140,000 ac.ft of water) drawing from the ESRPA since 1987 (Figures 5 and 6 and Table 3). The "curtailment scenario" run of the new ESRPA model concluded that annual depletions from groundwater pumping for irrigation are about 2.01 maf, applied to about 1.11 million acres (Table 3, based on Cosgrove, et al, "Curtailment Scenario", 2004).

Economic Importance of ESRPA-Dependant Springflow

The appropriation doctrine is the central tenet of Idaho water law. As the understanding of the hydrology of the basin has improved, the state has made it clear that the application of the appropriation doctrine extends to the relationship between groundwater and surface water. This is important, because it means that since the ESRPA is tributary to the Thousand Springs and to the springs near American Falls, many of the wells drawing from the ESRPA are junior to springwater users. Both irrigation system improvements and drought are partly responsible for the declining springflows. Drought cannot be controlled, and irrigators are under no obligation to "waste" water, so the water rights of both groundwater users and springflow dependant surface water users are subordinate to these causes of decline. However, given the declining springflow, and water calls from springflow users, the application of the appropriation doctrine would shut off the most junior users first – and many of the most junior users are groundwater irrigators.



The 1.6 maf flow (Contor, et al, "No Change Scenario", 2004) from springs near American Falls provide a large part of the natural flow and storage water supplies used by irrigation projects between American Falls and Milner – including the Twin Falls and North Side projects. These projects hold natural flow rights and refill rights to this springwater with priorities ranging from 1900 to the 1930s. Since the technology for deep well pumping was not developed until the 1950s, it should be clear that essentially all up-gradient groundwater users are junior.

In the case of Thousand Springs, the picture is more complicated. While some spring users predate groundwater pumping, and are clearly senior, the majority of springwater uses have priorities ranging from the 1950s, 60s and 70s. Thus some groundwater rights are senior to some springwater rights and junior to others. Table 3 shows the estimated acreage and water diversion by groundwater pumping from the ESRPA according to the information used in the new ESRPA model (Cosgrove, et al, "Curtailment Scenario", 2004). For example there are 663,000 "effective" acres with groundwater rights junior to 1961, where effective acres counts both land supplied with groundwater only, and a share of land irrigated with mixed ground and surface water sources.

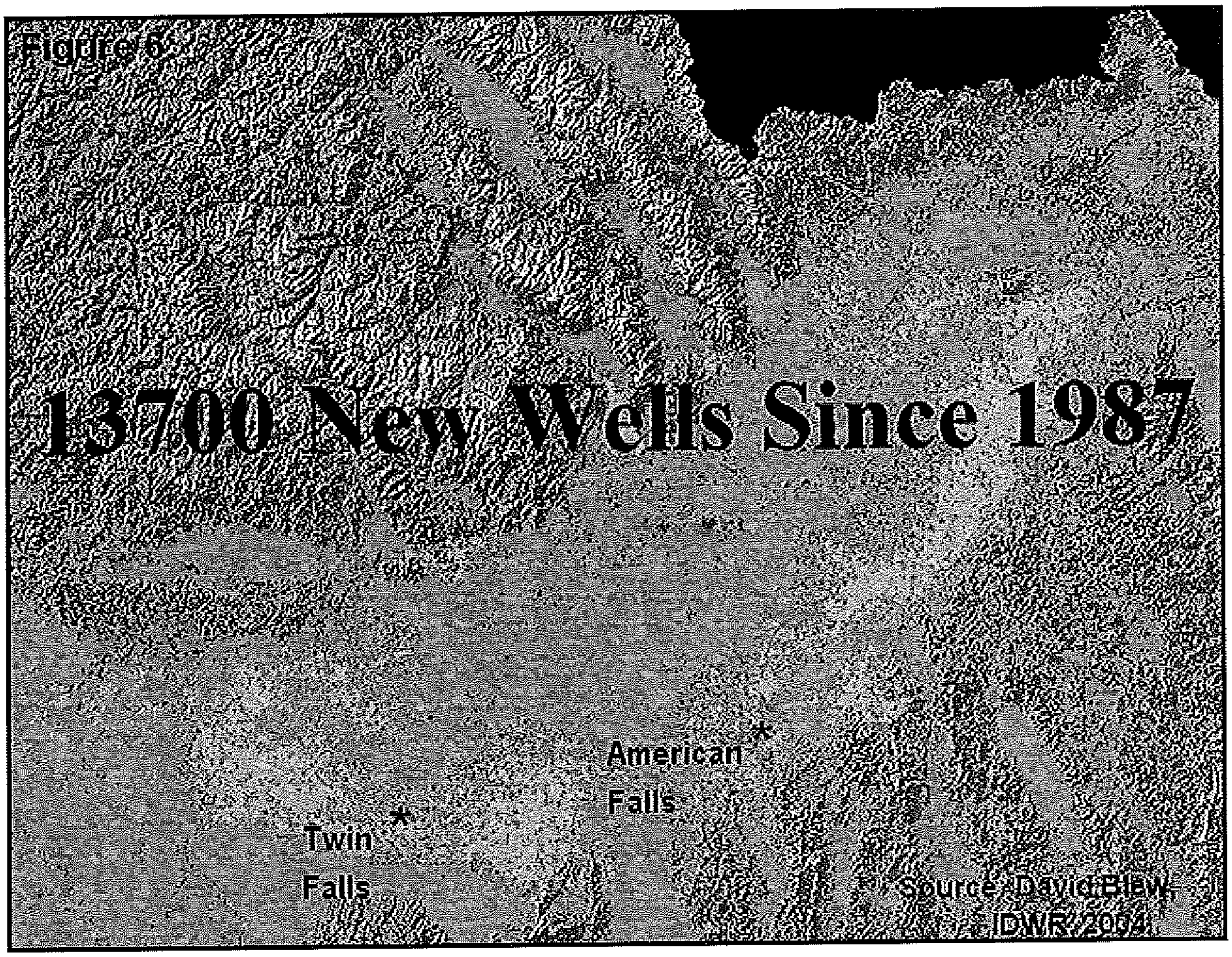


Table 3: Acreage and Priority Dates of Groundwater Pumpers

Priority Dates of Groundwater Pumpers	Estimated Groundwater Diversion by Priority Date (Acre-feet)	Estimated Groundwater Acreage by Priority Date (acres)
All Pumping	2,010,000	1,111,000
Post 1/1/1949	1,790,000	989,398
Post 1/1/1961	1,200,000	663,284
Post 1/1/1973	680,000	375,861
Post 1/1/1985	140,000	77,383

Sources:
Cosgrove, et al, 2004, "Curtailment Scenario", Table 1 and Appendix A Table 1

Economic Importance of ESRPA-Dependant Springflow

Since the Snake River above Blackfoot is a losing reach, it would not make much sense to say that irrigation in that reach depends on water supplies from springflows. However, irrigators in that area are not that easily let off the hook. Because the ESRPA and the river are closely linked in that reach, their water supply does depend on the health of the ESRPA. The runs of the new ESRPA model (Cosgrove, et al, "Curtailment Scenario", 2004) show very clearly that groundwater pumping causes aquifer declines and increases leakage from the upper reaches of the river to the aquifer. Even if it is already a losing reach, groundwater pumping from the ESRPA can be shown to take more water away from surface water users above Blackfoot.

ECONOMICS OF WATER USES IN THE EASTERN SNAKE RIVER BASIN

Given the hydrology discussed in the previous section, we now shift to a discussion of the economics of springwater use in southern Idaho.

Irrigated Crops in Southern Idaho

Irrigated crop production in southern Idaho is a major industry. Twelve counties stretching along the Snake River from Rigby to Bliss (Jefferson, Bonneville, Bingham, Bannock, Power, Blaine, Cassia, Minidoka, Lincoln, Jerome, Gooding and Twin Falls) have a total of 1,898,000 irrigated acres according to the 2002 Census of Agriculture. This includes most, but not all, of the land irrigated from the Snake River and the ESRPA. The market value of crops sold in 2002 from these twelve counties totaled $1.02 billion, most of this from irrigated cropland.

One can think of the acreage of irrigated crops reported in the 2002 Census of Agriculture for these twelve counties by visualizing a pie cut almost into quarters - one quarter for alfalfa hay, one quarter for wheat, one quarter for potatoes and sugar beets, and a final quarter for all the other crops (Figure 7). The irrigated alfalfa quarter totals 474 thousand acres. Almost another quarter, 426 thousand acres or 23 percent, of the land is used for wheat. Another near quarter, 23 percent or 431 thousand acres of the irrigated land grows potatoes and sugar beets. The remaining piece, just larger than a quarter consists of everything else – barley (12 percent), corn silage (4 percent), dry beans (3 percent), corn grain (1 percent) and a catch-all category which includes irrigated pasture, crops not harvested, and all other minor crops not enumerated by the Idaho Agricultural Statistics Service (9 percent). Note that small grains, wheat and barley together, make up over one-third of total irrigated acreage in the 12 counties.

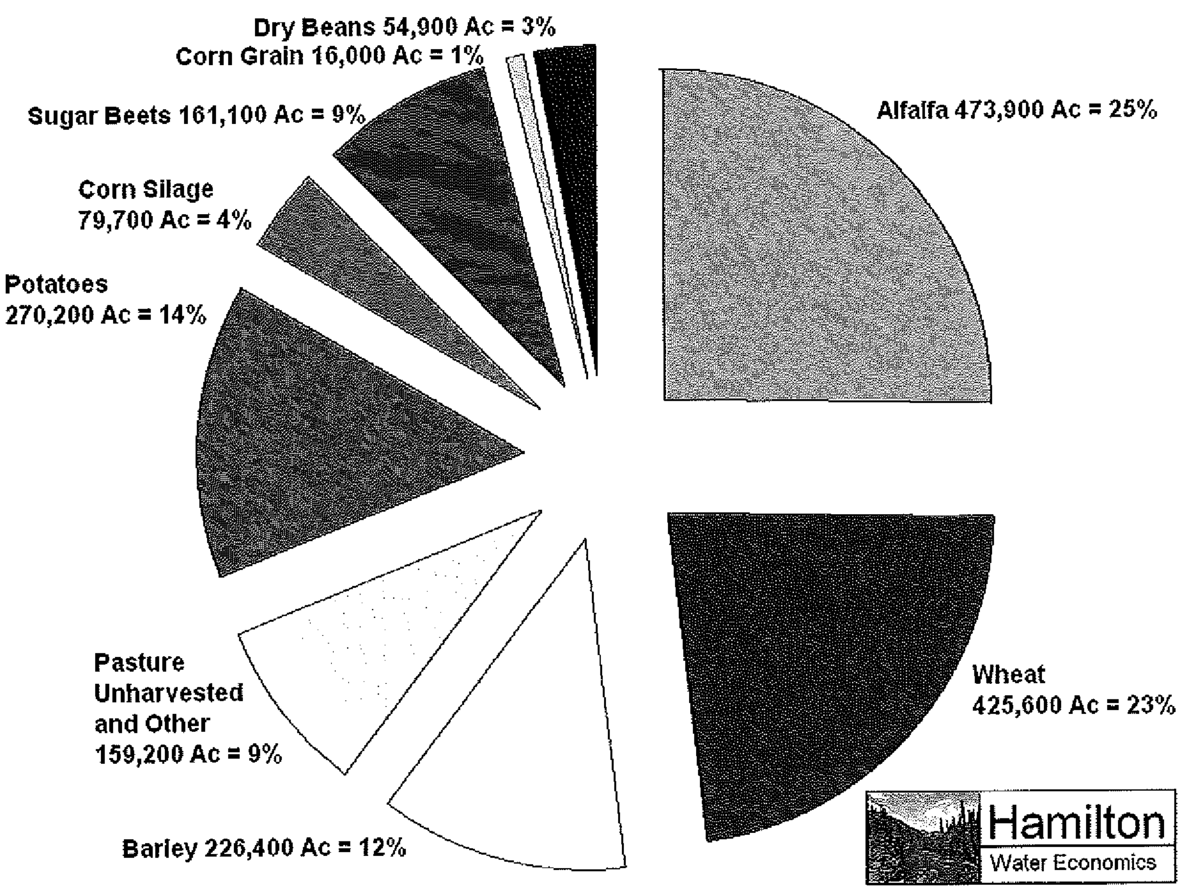
Irrigated Crops Depending on Springflows

There are three tracts of irrigated cropland that depend wholly or in part on ESRPA springflows. The larger tract includes the half dozen large irrigation projects with two-thirds of million acres of irrigated land that rely significantly on springflows at American Falls for their natural flow and storage water supplies. The second area is less well defined, consisting of the area above Blackfoot, where the level of the ESRPA affects the reach gains and losses that determine the natural flow water supply of the many irrigation projects in this area, before the river is mostly dried up at Blackfoot. The third set of projects is provided with water by springs in the Thousand Springs reach. These lands include a small irrigated area within the Snake River Canyon served directly by the springs, and a larger area on down the Snake River where pumps lift river water, most of which originates from Thousand Springs, to irrigate the high benches along the river.

Crops using water from American Falls springs

At the time the Twin Falls and North Side projects were proposed as Carey Act projects in the early 1900s (Chapman), there was little available natural flow at Blackfoot during the irrigation season.

Figure 7: All 12 County Percent of Irrigated Acres



For example the USGS reports: "Late in summer of 1905 there was no flow in Snake River for a distance of 10 mi in vicinity of Blackfoot." (USGS, 2003). Below Blackfoot some 1.6 million acre-feet of springflows and reach gains (about 2,250 cfs) enter the Snake River (Table 1), which became the core of the water supply for these projects. Twin Falls Canal Company holds rights to 3000 cfs of flow, with a priority date of 10/11/1900. The North Side Twin Falls project has a much smaller 400 cfs flow right sharing the same priority date. In the following years these two projects, plus a number of other irrigation projects in the Magic Valley region acquired other, more junior water rights. Appendix tables A2 and A3 show these flow rights and priority dates.

These flow rights were not adequate to provide a full water supply for the land area of these projects, so storage was necessary. Jackson Dam on the South Fork of the Snake River in Wyoming provided some of the required storage – 97,000 acre-feet for the Twin Falls project and 312,007 acre-feet for the North Side project. However, a large part of the storage needed for the two projects was developed at

American Falls reservoir. Twin Falls project holds 148,000 acre-feet of storage with a 3/29/1921 refill date and the North Side project holds 9,247 acre-feet of storage with the same 3/29/1921 refill date, plus 322,000 acre-feet with a junior 3/31/1921 refill date. The American Falls storage is refilled partly with natural flows that come downriver in wet years and in the off season. However the more reliable sources for refill are the off season springflows and reach gains in the Blackfoot to Neeley reach of the Snake River. As shown in Appendix tables A2 and A3, this junior refill priority storage in American Falls is shared with a number of other irrigation projects in the area. Table 2 shows the present irrigated area of these projects, some 648,000 acres.

Since the water that supplies these projects is a blend of natural flow (most but not all of which comes from springflow) and storage (which is also a blend of natural flow in the upper river and springflow near American Falls) it is not possible to specify exactly which water and which land is due to springflow. However one can say that the annual springflows and reach gains from the Blackfoot to Neeley reach total about 1.6 million acre-feet. A full water supply for the projects in this area requires diversion of between 4 and 5 acre-feet per project acre. Choosing the midpoint of 4.5 acre- feet per acre means that the 1.6 million acre-feet of springwater is enough to supply about 362 thousand acres of land distributed in the various irrigation projects between American Falls and Milner. Thus, of the mix of water sources that serve these irrigation projects, about 56 percent of this water is spring-flow originating from the ESRPA.

The crops grown on these 362 thousand acres of spring-dependant land should be quite similar to the value of crops on other land in the region. Note that the six core counties of the Magic Valley (Gooding, Jerome, Lincoln, Minidoka, Twin Falls and Cassia) produced crops with a market value of $522 million on 1.046 million irrigated acres (Table A-1 and Figure 8). This is almost $500 of crop output per irrigated acre. Applying the $500 figure to the 362 thousand acres that are dependant on springflows and reach gains from the Blackfoot to Neeley reach of the Snake gives an estimate of about $181 million of crops that depend on this springflow.

What effect does it have when springflows in this reach decline? First, it means that both natural flow supplies and storage

Box 2: How do Farmers Adjust to Water Shortage?

This report has used the $500 average crop value per acre across south-central Idaho to estimate the value of crop production that depends on springflow. That is obviously only an approximation, since actual crop value varies by region, land characteristics, and typical crop mix. The more interesting and more difficult question is what happens to the value of crop production if water is short?

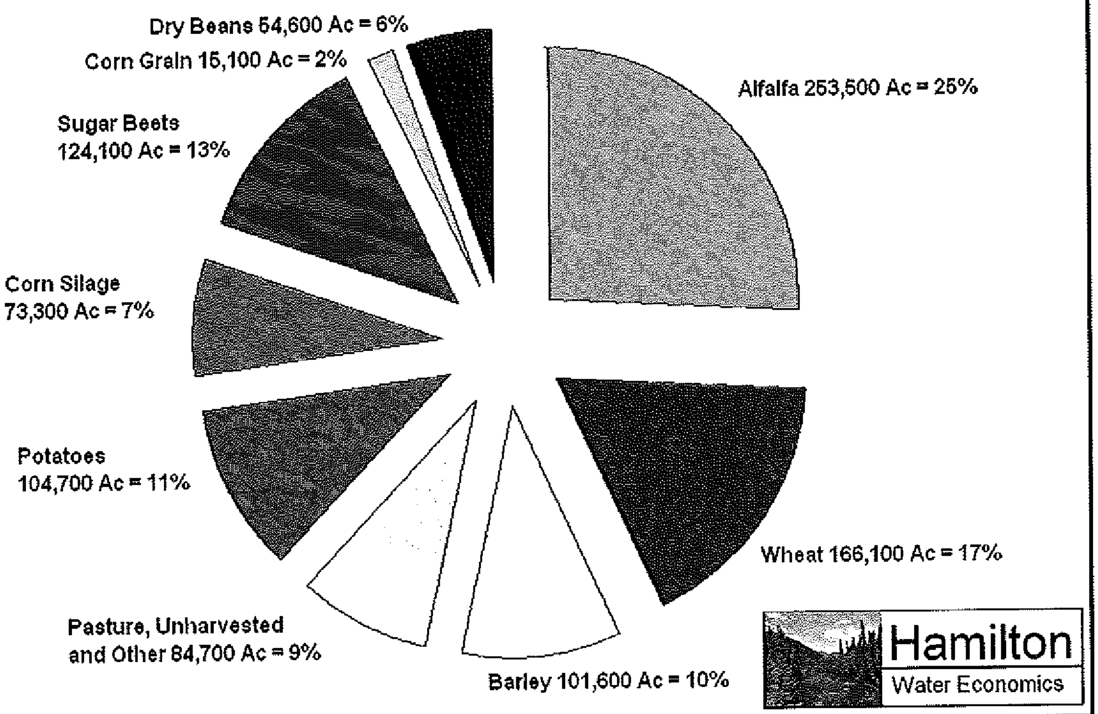
Several places in the main text of this report have mentioned the creative things which farmers do in response to water shortage. If they have enough warning, farmers plant crops that use less water. They concentrate what available water they have on high valued crops. They may idle some of their poorest land. If the shortage is chronic, they line canals and install sprinkler systems. If the shortage is sudden, or if they bet wrong, then they may lose some crop yield or crop quality.

Some of these responses will decrease the value of crops produced. Other responses will increase operating costs or capital costs. Still, these effects will in general be less than the $500 per acre crop value would imply. Using the $500 figure will at best give an upper bound on the economic impacts of water shortage.

It would be possible to develop linear programming models to show how farmers would actually respond to water shortage, but building such models was beyond the scope of this project. However, if the state is serious about making major water policy changes, such models should be built, especially models capable of estimating farmer response to groundwater curtailment scenarios.

recharge are compromised, especially in dry years. In 2004, water supplies to both Twin Falls and North Side projects were restricted, and the irrigation season ended early. Farmers in the area report significant effects from this water shortage, including shifts to lower water using and lower valued crops, lost last cuttings of alfalfa, lower sugar levels in immature beets, problems digging dry potato fields, and excess nitrogen problems in water shorted corn silage. Larger shortages would prove more difficult to adjust to. If crop value were proportional to water use, then the 4.5 acre-feet per acre diversion requirement would imply that $111 of crop output value would be lost for each acre foot of springflow decline at American Falls. However, farmers are resourceful in making the best use of available water, so the lost crop value per acre-foot would be less than that (see Box 2).

Figure 8: Lower 6 County Percent of Reported Acres
(Gooding, Jerome, Minidoka, Casia, Twin Falls & Lincoln)



The biggest effect from water shortages caused by springflow declines is probably not on the crops grown in this region, but how they are grown. If there are regular, persistent water shortages, then the irrigation projects and the farmers themselves are forced to emphasize efficiency of water use. Farmers have an incentive to do a better job of applying water to their fields, they use irrigation scheduling, they install sprinklers, and they use pump-back systems. Leaky canals are lined, and delivery scheduling refined. While all these practices help stretch the declining water supplies in the area (which would seem like a good thing) they also reduce the amount of water that infiltrates to recharge the lower end of the ESRPA (which aggravates the problems at Thousand Springs and downstream). Thus the costs due to declining springflows in the American Falls reach have three parts -- first the reduced production from any water-short crops, second the very significant costs of irrigation system improvements and changes in irrigation practices needed to stretch the available water, and third the externality costs imposed lower down the ESRPA as reduced recharge results in declining water tables and reduced springflow.

Economic Importance of ESRPA-Dependant Springflow

Crops whose water supply depends on reach gains and losses above Blackfoot

The net reach losses between Heise and Blackfoot totaled 467 kaf for the 1980 to 2002 calibration period of the new ESRPA model (Table 1). Since these gains and losses are distributed along the river, it is probably not meaningful to identify an acreage of land in this area that depends on springflow. However, anything that affects these reach gains and losses has the potential to significantly affect water supplies available for irrigation both above and below Blackfoot. If reach losses increase, then less natural flow water is available for irrigators above Blackfoot, and less out of season water flows below Blackfoot to refill storage space in American Falls.

One of the model runs included in the "Curtailment Scenario" report on the new ESRPA model shows the steady state effects of curtailing all groundwater pumping from the ESRPA. These results are shown in the first two columns of Table 4. These numbers can also be used to estimate the steady state effects which past groundwater pumping has had on Snake River reach gains and losses. Given the calibration period reach gains and losses, and the changes attributable to groundwater pumping, one can compute what reach gains and losses would have been without groundwater pumping. This estimate is shown in the rightmost column of Table 4. For the reach above Blackfoot, this says that in the absence of groundwater pumping this reach would have had gains of 182 kaf, but groundwater pumping reduced that by 649 kaf, to a reach loss of 467 kaf. In the absence of groundwater pumping

Table 4: Steady State Reach Gains from Curtailment of All Groundwater Pumping

	Steady State Reach Gain from Curtailment		Average Reach Gain for Calibration Period	Implied Reach Gain w/o Groundwater Pumping
	(cfs)	(kaf)	(kaf)	(kaf)
Ashton - Rexburg	405	293	148	442
Heise - Shelly	164	119	-355	-236
Shelly - Blackfoot	328	237	-261	-23
Total Above Blackfoot Reach	897	649	-467	182
Blackfoot - Neeley	1,093	791	1,609	2,400
Neeley - Milner	133	96	20	117
Total Blackfoor - Milner Reach	1,226	888	1,629	2,517
Devil's Washbowl - Buhl	334	242	702	943
Buhl - Thousand Springs	139	101	1,142	1,243
Thousand Springs	82	59	1,274	1,334
Thousand Springs - Malad	8	6	56	62
Malad	83	60	862	922
Malad - Bancroft	7	5	72	77
Total Thousand Springs Reach	653	473	4,109	4,581
Total All Reaches	2,776	2,010	5,271	7,280

Sources: Columns 1 and 2 from Cosgrove, et al, "Curtailment Scenario", Table 1, 2004
Column 3 from my Table 1
Column 4 = column 2 + column 3

the reach between Blackfoot and Milner would have had gains of 2.517 maf, but groundwater pumping reduced that by 888 kaf, to a reach gain of 1.629 maf. In the absence of groundwater pumping the Thousand Springs reach would have had gains of 4.581 maf, but groundwater pumping reduced that by 473 kaf, to a reach gain of 4.109 maf.

These are significantly large losses of water supply that water users all along the Snake River (many of them senior right holders) are already experiencing as a consequence of groundwater pumping (much of it pumped by users holding junior rights). This is a theme that will be repeated several times in this report – senior water right holders are already experiencing the economic effects of a curtailed water supply, while junior groundwater users are enjoying the benefits of the water which they continue to pump without restriction.

In the reach above Blackfoot, about half the 649 kaf increase in reach losses would be during the summer irrigation season, reducing the natural flow available to farmers in this reach by 325 kaf. At 4.5 acre-feet diversion per acre this is enough water for 72,000 acres. At $500 per acre, the negative impact of groundwater pumping on surface water dependent crop value above Blackfoot would be $36 million per year. This is an upper bound on damages caused by groundwater pumpers to irrigators above Blackfoot, if not all of this water is needed for irrigation, and because farmers are resourceful in allocating limited water supplies to minimize the economic impacts when water supplies are short (sees Box 2).

The impact of groundwater pumping on water supplies to farmers between Blackfoot and Milner, is the 888 kaf reduction in springflow in the

Box 3: Measuring Economic Impact

One of the most difficult parts of talking about economic impacts of a policy is to communicate correctly the units in which that impact is being measured. This report estimates the economic value of springflow or changes in springflows in terms of the value of crops that could be grown with that water. However, we all know that the value of production is not what is really important. Rather, it is the income (the profits, the wages, the return on investments) that is really important. Typically income is only 10 to 20 percent of gross output value. This report stopped with gross output value because there is no state economic model available capable of estimating the income effects of changing water use, and building such a model was beyond the scope of this project. Hopefully the State of Idaho will build such a model in the near future as they consider the economic impacts of changing water use.

If we had a good Idaho economic model, we could go one step further and talk about how changes in crop production also generate income in other sectors of the economy that sell inputs like fertilizer, machinery, and insurance to farmers, and the sectors where farmers and laborers spend their income on consumer goods like food, clothes, appliances and cars.

The numbers in the Hazen and Ohlensehlen report were based on an economic model for the Twin Falls-Jerome-Gooding-Lincoln County region. They estimated that the net change in exports from the region would be $251 million for their scenario 1 and $4 million for scenario 2. (Scenario 1 curtailed some dairies plus the farms that supply them with feed, and scenario 2 kept the dairies, but curtailed low valued crops on the affected farms.) These export changes are conceptually similar to the change in crop value figures that I use in this report. It was when they looked at the net change in sales of products and services by water users and the supporting sectors that they got the $777 million number for scenario 1 that has been quoted in the press. The corresponding net change in sales for scenario 2 of $16.8 million has been largely ignored by the press. Again, of course, sales is a rather meaningless measure of economic impact. It is really the effect on incomes that matter. Hazen and Ohlensehlen reported that scenario 1 would result in a net income loss of $117 million for water users and supporting sectors, and scenario 2 would result in a $2.9 million net income loss. These more relevant numbers, especially for the most plausible scenario 2, have also received little attention in the press.

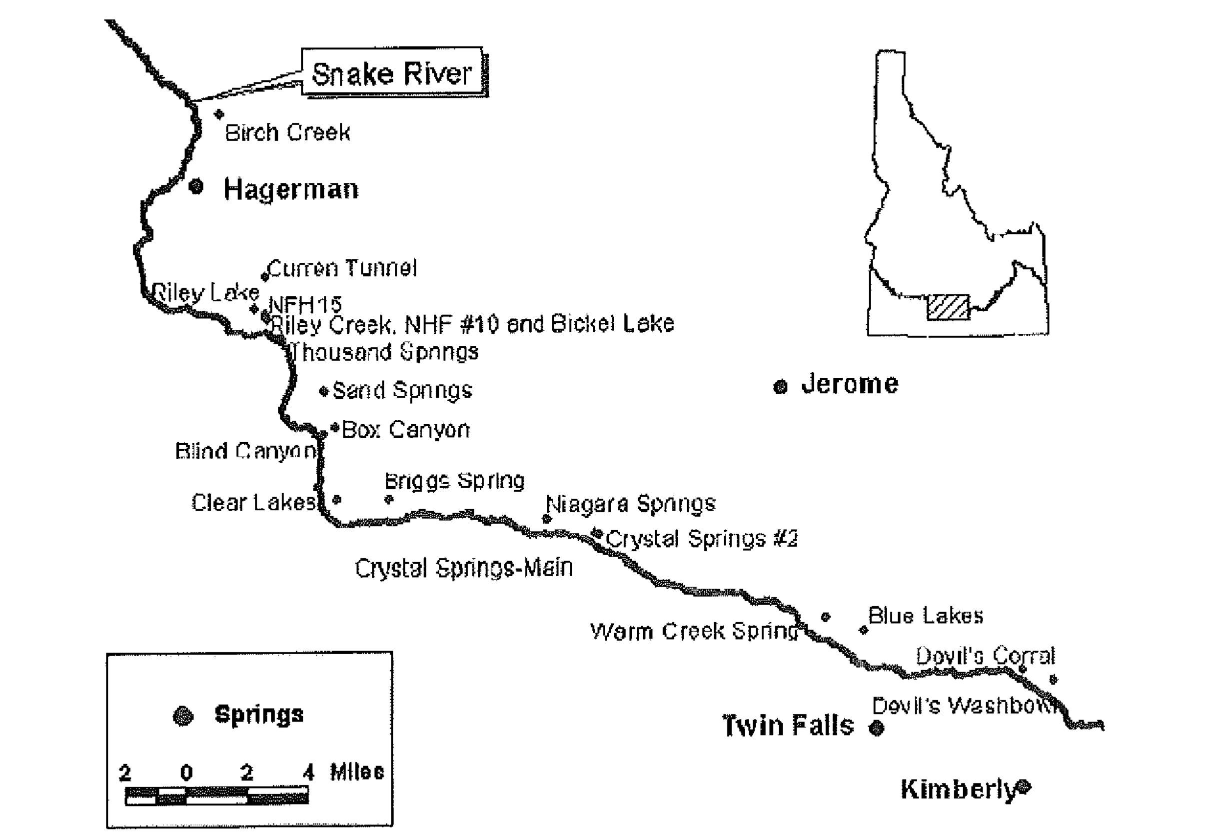
Economic Importance of ESRPA-Dependant Springflow

American Falls area, plus the other half of the increase in reach losses above Blackfoot (325 kaf) that occur outside the irrigation season and could otherwise have been used to refill storage in American Falls Reservoir. Thus, without the effects of groundwater pumping water users in the Blackfoot to Milner reach would have 1.213 maf more water supply. At 4.5 acre-feet per acre this is enough water for 270,000 acres, more than a third of the irrigated land in these projects. This number goes a long way toward explaining the current water supply problems of the irrigation projects between Blackfoot and Milner. This water was their insurance against occasional dry years – insurance they have now lost. The lack of this water is what has pushed them to line canals and change to sprinklers, with disastrous effects on the ESRPA, and on Thousand Springs flows. This reduced water supply explains why it is now rare that much of this water ever flows downstream below Milner Dam.

Crops using water from Thousand Springs

There are about 5,500 acres of irrigated land, primarily in the Hagerman Valley that have rights to springwater from the Thousand Springs reach. Many of these water rights are very senior. Using the $500 per irrigated crop value figure would mean $2.75 million in irrigated crop value depending on Thousand Springs water. The figure could be higher because this land includes some high-valued crops such as vineyards, orchards and greenhouses.

Figure 9: Location of Springs in Thousand Springs Reach



Source: Johnson, et al, 2002

Springflow declines have already compromised water supplies in this area. In response, groundwater appropriators on the north side have already made adjustments to their water use and "... constructed water management and delivery structures that provide up to 10,000 acre-feet of replacement water per year to approximately 1,600 irrigated acres in the Hagerman Valley" (Brendeke, 2004). The costs of these efforts have been considerable, and have mitigated some but not all of the costs borne by senior irrigators in the Thousand Springs reach. Any further declines in springflow will lead either to more lost crop production or more costs for alternative water supplies.

Irrigation diversions essentially dry up the Snake River at Milner Dam during the irrigation season in most years (Figure 2). It is primarily Thousand Springs flows, plus some irrigation drains and surface return flows that provide the reach gains which reconstitute the river within a few miles downstream. Nearly all the water in the river between Milner and Murphy can be considered to originate from springflow. In the late 1960s and early 1970s high-lift pumps were developed to lift river water to land on the high benches both north and south of the river. Even with their relatively recent priority dates, these high-lift projects are senior to many of the groundwater users pumping water from the ESRPA. Water use by these projects totals about 355,000 acre-feet (Table 5).

Table 5: Irrigation Water Consumption and Priority Dates for Users Between Thousand Springs and Murphy

Project	Priority Date	Use in Acre-Feet
Salmon Falls	1/1/1970	33,000
Bell Rapids	1/1/1969	46,500
Misc. King Hill	1/9/1970	125,000
Grand View	1/8/1970	70,100
Grand Mutual	1/11/1970	45,600
CJ Strike to Murphy	1/12/1970	34,800
		355,000

Source: Extracted from Modsim Model of Upper Snake River, Roger Larson, US Bureau of Reclamation

If the consumptive diversion for this high-lift pump land is 1.81 acre-feet per acre, the same as the groundwater diversion assumed for the "Curtailment Scenario" run of the new ESRPA model, then this is enough water to serve 196,000 acres of cropland. Essentially all of the crops grown on these 196,000 acres can be considered as part of the value of crops grown with springwater. At $500 per acre, this land produces crops valued at $98 million using mostly springwater.

To date, the water supplies of these high-lift river pumping projects has not been restricted by springflow declines. In fact, the high cost of powering the pumps has proven to be a much greater threat to the continued operation of these projects, and several years ago made many of these farmers willing participants in Idaho Power Company's irrigation buyout program. The October 1984 Swan Falls Agreement imposed a minimum Snake River flow of 3,900 cfs at Murphy during the irrigation season. In recent years the July flow has fallen almost to that mark, so further springflow declines could invoke the minimum flow clause. The usual assumption has been that this would result in the shutoff of enough of the most junior river pumpers to assure the 3,900 cfs flow. Since there are groundwater pumpers with even more junior water rights taking water from the ESRPA, a strict interpretation of the appropriation doctrine could shift attention to them.

Economic Importance of ESRPA-Dependant Springflow

Proposals are currently being circulated that would lease or buy out some of the water rights of these high-lift river pumpers and deliver the water downstream to contribute to required flows for endangered salmon. Such a buyout would sidestep the minimum streamflow problem at Swan Falls, although the cost of the buyout might be considered as a cost attributable to groundwater pumping.

Aquaculture Depending on Springflows

The aquaculture industry is a high-profile user of Thousand Springs water. Commercial trout production requires assured flows of high quality cold water. Thousand Springs water, flowing at a nearly constant 59 degrees is uniquely suited for trout aquaculture, and has made this river reach the dominant commercial trout growing and processing site in the world. While there are a few small operations that use stream water, the vast majority of Idaho trout production depends on spring flows from the ESRPA.

The commercial trout industry

To describe the economics of the aquaculture industry, the short note by Bill Hazen and Bob Ohlensehlen, and the Four County Magic Valley economic model on which it was based, provide good starting points. The model shows that fish farming in the region produces fish valued at $41.8 million. Most of these fish are processed within the region, and when processed have a product value of $78.6 million, most of which is exported from the region. The model also showed that fish farms provide 831 jobs, and the processing step provides an additional 484 jobs, for a total of 1,315 direct jobs.

Figure 3 showed that springflows in the Thousand Springs reach have declined by 21 percent since the high flows of the early 1950s. From the perspective of the aquaculture users it is more important how much springflows have declined below decreed rights at the particular springs used for fish farms. Because springflow decline was not of much concern until recently, the flow data from individual springs varies in quality and consistency. Flow data from Clear Springs and from Rangen are presented as examples of the flow declines experienced by fish farms.

Clear Springs Foods has three farms that are currently impacted by decreased spring fed surface water flows. Their farm at Crystal Springs has decreed water rights with priorities ranging from 1969 to 1975 totaling 335.1 cfs, but the 2004 low flow was 172.1 cfs. Their Snake River Farm has 1933 to 1971 decreed water right totaling 117.67 cfs, and in 2004 the low flow was 84.6 cfs. Their Clear Lake Farms complex (Clear Springs Foods Clear Lake Farm and Idaho Trout Producers Clear Lake Farm) have decreed water rights with 1966 to 1972 priorities totaling 436.6 cfs, but in 2004 low flow fell to 303.4 cfs. (Personal communication from Dr. Randy MacMillan, Clear Springs Foods, November 19, 2004.)

The Rangen fish farm uses water from springs accessed by the Curran Tunnel. They own three different rights to this source; a 1957 right to 1.46 cfs, a 1962 right to 48.54 cfs, and a 1977 right to 26 cfs. The IDWR argues that there may never have been enough water from the Curran Tunnel to fill the most junior 26 cfs right, but accepts the validity of the two senior rights (Dreher, 2004). Flows available from the Curran Tunnel have declined sharply in recent years (see Figure 10, based on Dreher, 2004). While flows available to Rangen in 1987 were already below the amounts decreed in their two most senior rights, these flows fell an additional 60 percent by 2003.

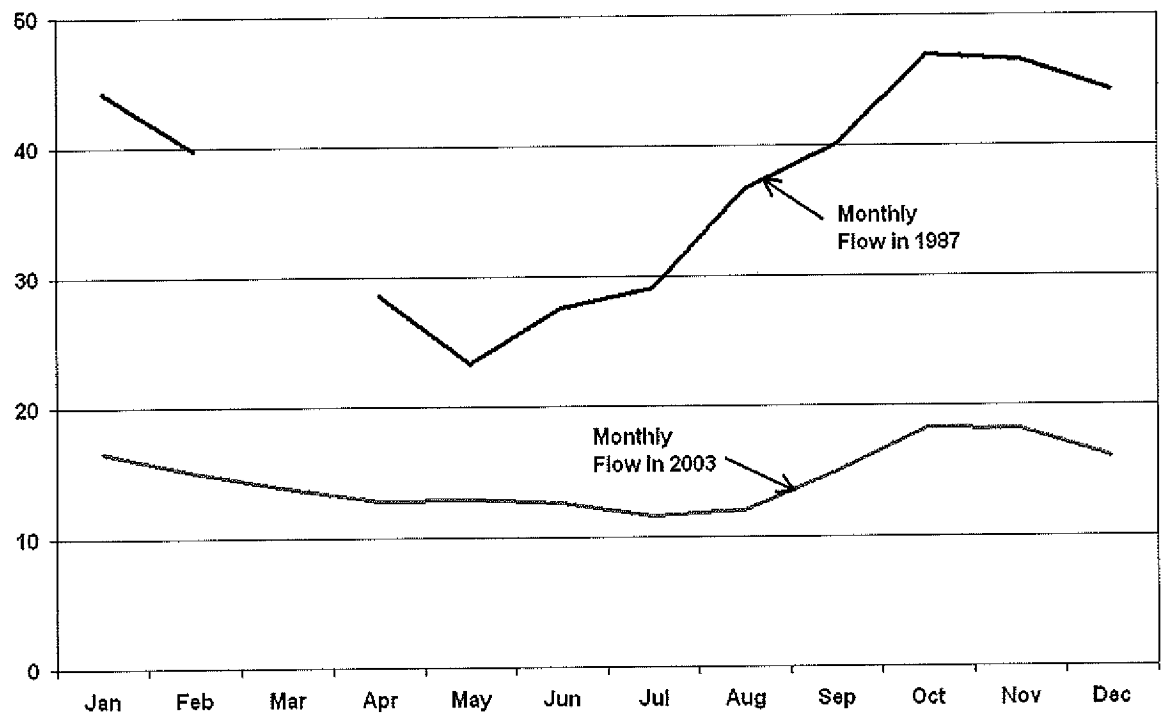
These springflow declines, to levels well below decreed rights, must have already imposed substantial costs on aquaculture operations all along this reach of the river.

Economic Importance of ESRPA-Dependant Springflow

The assumption in the Hazen – Ohlensehlen paper that commercial trout production is proportional to water supply also seems like a good starting point. Fish farms generally pass springwater once through a series of raceways. This single pass is dictated by volume of dissolved oxygen present, water temperature increases, and the buildup of uneaten food, feces, and pathogens. Treating, cooling and recycling the water may be technologically feasible, but the cost would be prohibitive in an industry linked as closely to world markets as the aquaculture industry. All this means that when springflows drop below decreed water rights, fish production will decrease in almost direct proportion.

Water use by the processing portion of the industry is another matter. Both water supply shortages and required levels of treatment for discharges are encouraging trout processors to recycle more of their process water, at considerable cost.

Figure 10: Water Supply to Rangen Trout Farm in 1987 and 2003



Source: Dreher, Rangen order, March 10, 2004

Other aquaculture facilities

There are several other aquaculture facilities that also use springflow, but are non-commercial so they are not included in the commercial fish farm numbers presented above. These include an Idaho Department of Fish and Game fish hatchery (Hagerman State), one US Fish and Wildlife Service hatchery (Hagerman National), one Army Corps of Engineers Hatchery (Magic Valley Steelhead), the University of Idaho Aquaculture Lab, and the Idaho Power Company (IPC) steelhead mitigation hatchery at Niagara Springs.

All five of these projects hold rights to springflows in the Thousand Springs reach. The IDFG Hagerman Fish Hatchery, the largest resident trout production facility in Idaho, has a 1947 water right for 42 cfs from Tucker Springs and 61 cfs from Riley Creek. The IPC Niagara Springs Fish Hatchery, built in 1966 as mitigation for the steelhead runs blocked by the Hells Canyon dam complex, holds rights to 132 cfs water from Niagara Springs. The US Fish and Wildlife hatchery at Hagerman, which produces both steelhead and rainbow trout, holds a water right for 67 cfs of springflow. The Magic Valley Steelhead Hatchery was built in 1987 on the south side of the river near Crystal Springs. The Magic Valley Steelhead Hatchery is part of the Lower Snake River Compensation Program to mitigate for anadromous fishery losses caused by four federal dams constructed on the lower Snake River. An average flow of 125 cfs is piped across the river from Crystal Springs to supply the hatchery. The University of Idaho Aquaculture Lab at Hagerman, used primarily for aquaculture research, has rights to 4 ½ cfs of springwater. These five facilities, like the commercial trout farms, are all vulnerable to falling springflows.

While these are not commercial enterprises, they do produce outputs of economic value. The trout produced in the IDFG and USFWS facilities are used in stocking programs to support recreational fishing in Idaho and the steelhead trout produced in the IPC and the USFWS facilities support recreational and commercial steelhead fishing across Idaho and the Pacific Northwest. The UI lab does research in support of both commercial and non-commercial aquaculture across the region.

One way of thinking of the economic impact of these non-commercial fish facilities is to look at their budgets. Presumably the fish produced in these conservation hatcheries are worth at least as much as it costs to produce them. Table 6 provides hatchery budget information. This table shows that operating costs at these four conservation hatcheries have averaged $2.6 million in recent years. While the only capital cost data in Table 6 is for Hagerman National Fish Hatchery (averaging $263,000 in recent years), facility cost (measured either as capital spending or depreciation) is a legitimate component of fish production costs, and might total a million dollars per year for the four hatcheries.

Gary Fornshell, UI Extension Aquaculture Specialist, reports that the UI Hagerman Fish Culture Experiment Station receives about $300,000 of state money for salaries and operations. In addition the station brings in about $3.2 million yearly in grant support for research.

Looked at this way these five facilities (four conservation hatcheries and the research lab) account for at least $7 million in annual economic activity, all of which can be said to depend on springflows in the Thousand Springs reach.

This $7 million is certainly an underestimate of the economic importance of the conservation hatcheries. These hatcheries provide trout that are stocked in Idaho rivers and lakes to support recreational fisheries. The steelhead produced also support recreational, commercial and tribal fisheries in Idaho, lower down the Snake and Columbia Rivers, and in the Pacific Ocean. The economic impact of the Idaho recreational fisheries depending on these conservation hatcheries is many times the $7 million cost of producing the fish. A study by Reading (1999) estimates that the 1992/93 Idaho steelhead season resulted in $90 million of recreational spending in Idaho and supported nearly 2,700 jobs. While there are a number of other steelhead hatcheries in Idaho, the hatcheries in the Thousand Springs reach provide a portion of the fish that make this steelhead fishery possible.

Economic Importance of ESRPA-Dependant Springflow

Table 6: Spending by Conservation Hatcheries in Thousand Springs Reach

	Hagerman State Fish Hatchery	Magic Valley Fish Hatchery	Hagerman National Fish Hatchery				Niagra Springs Fish Hatchery
	Idaho Fish & Game (Resident Trout)	US Army Corps of Engineers (Steelhead)	US Fish & Wildlife Service (Steelhead)		Trout)		Operated by Idaho Fish & Game for Idaho Power Co (Steelhead)
Fiscal Year	Operating Costs Only	Operating Costs Only	Operating Costs	Capital Outlay	Operating Costs	Total Spending	Operating Costs Only
1999	465,894	558,263	611,699	67,915	12,000	691,614	778,644
2000	489,672	558,263	591,781	17,218	12,000	620,999	821,545
2001	538,122	531,863	681,731	1,126,396	11,955	1,820,082	542,763
2002	534,023	531,863	706,788	39,790	14,441	761,019	956,998
2003	551,788	592,876	714,096	128,184	19,586	861,866	985,279
2004		671,112	748,593	197,309	20,000	965,902	
Average	515,900	574,040	675,781	262,802	14,997	953,580	817,046

Sources:
Brian Kenworthy, Project Leader Hagerman National Fish Hatchery
Joe Clapman, Manager Hagerman State Fish Hatchery
Rick Lowell, Manager Magic Valley Fish Hatchery
Jerry Clapman, Manager Niagra Springs Fish Hatchery

Hamilton
Water Economics

Irrigated Crops Depending on Groundwater

Irrigation pumping junior to springwater users

The "Curtailment Scenario" run of the new ESRPA model implies that there are 1.111 million "effective" acres supplied with 2.01 maf of groundwater (see Table 7). (Effective acreage is an estimate of groundwater-only land plus a share of land served by both ground and surface sources.) The cumulative pattern of groundwater diversions through time and the priority of the various springwater users who have made delivery calls are shown in Figure 11. Table 7 also shows the estimated effective acreage junior to the five arbitrary cutoff dates used in the curtailment study. Thus 989,398 acres, or 89.1 percent of total groundwater pumping are junior to a 1/1/49 springflow right. In the same way 663,284 acres (59.7 percent) are junior to 1/1/61, 375,861 acres (33.8 percent) are junior to 1/1/73, and only 77,383 acres (7.0 percent) are junior to 1/1/85 springwater rights.

It is perhaps more useful to think of these junior groundwater rights in relation to the total irrigated acreage above the ESRPA. Brockway (6/24/2004) indicated that the total irrigated acreage above the ESRPA is 2,430,000 acres. Thus the effective total groundwater acreage is 45.7 percent of total irrigated acreage above the ESRPA. Acreage junior to 1/1/61 is 27.3 percent, and acreage junior to 1/1/85 is only 3.2 percent of total irrigated acreage.

Thus an upper bound estimate of the crop value impact of a cataclysmic scenario which curtails all groundwater pumping 100 percent would be 1.1 million acres times $500 or $550 million. This is certainly an unrealistic estimate of the impact of any likely curtailment scenario, because it is not likely that all groundwater pumpers would be curtailed, because it is unlikely that all those curtailed would be 100 percent curtailed, because farmers would be creative in how they adjust, and because

Economic Importance of ESRPA-Dependant Springflow

market forces would assure that as much of the curtailment as possible would fall on lower valued crops (see Box 2).

Figure 11: Eastern Snake Plain Aquifer Cumulative Groundwater Appropriation by Year
(Municipal, Domestic, Fire Protection & Fish Propagation Rights Not Included)

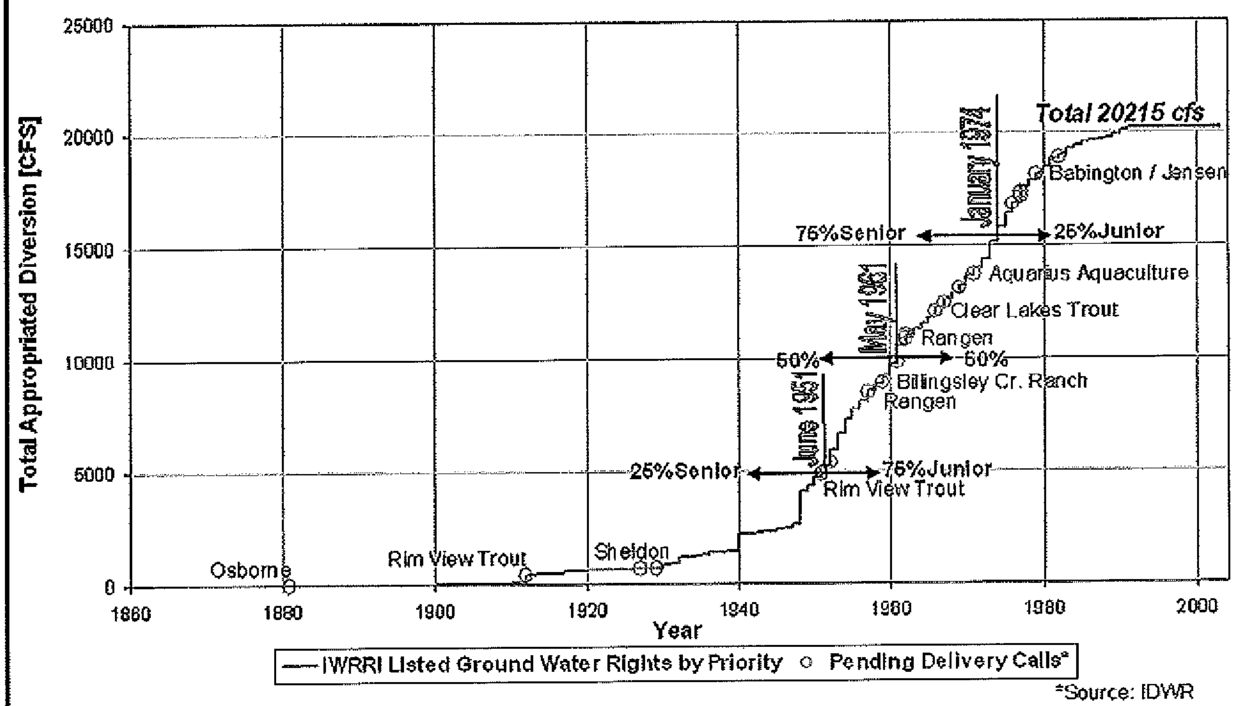


Table 7: Acreage and Priority Dates of Groundwater Pumpers

Priority Dates of Groundwater Pumpers	Estimated Groundwater Diversion by Priority Date (Acre-feet)	Estimated Groundwater Acreage by Priority Date (acres)	Percent of All Groundwater Land	Percent of All Irrigated land
All Pumping	2,010,000	1,111,000	100.0%	45.7%
Post 1/1/1949	1,790,000	989,398	89.1%	40.7%
Post 1/1/1961	1,200,000	663,284	59.7%	27.3%
Post 1/1/1973	680,000	375,861	33.8%	15.5%
Post 1/1/1985	140,000	77,383	7.0%	3.2%

Sources: Cosgrove, et al, 2004, "Curtailment Scenario", Table 1 and Appendix A Table 1

Effects of groundwater declines on senior groundwater users

The groundwater level declines documented in Figure 4 mean that senior groundwater users must pump their water from greater depths. Idaho law does not protect a well user from groundwater level decline as long as the pumping depth remains reasonable. However the costs of pumping from a greater depth, including power costs, well deepening costs, pump modification costs and possibly costs from reduced well yields are still costs that the junior groundwater appropriators are imposing on the senior appropriators.

A well adjusted deep well pump with typical pump and motor efficiency requires about 1.25 kwh to pump an acre-foot of water up one foot. Using the water diversion per acre figure implied in the ESRPA model "Curtailment Scenario" of 1.81 acre-feet per acre, then each foot of groundwater decline means that pumpers will consume an additional 1.81 * 1.25 = 2.26 kwh of pumping electricity per acre. With irrigation electricity priced at approximately 5 cents per kwh, this means that annual power costs for irrigation pumping increase by 11.3 cents per acre for each foot of groundwater decline. Brockway documents water level declines from zero to 25 feet across the ESRPA. While the relationship between well locations, depletion amounts and aquifer decline has not been worked out, the resulting cost being imposed on senior irrigation groundwater users could easily be $1 million or more. While well deepening costs, pump modification costs, and the costs of reduced well yields would be even harder to estimate, this could easily more than double the total cost of decline to senior groundwater users.

The experience of A&B Irrigation District is an example of this problem. A & B relies heavily on wells for their water supply, and aquifer declines have hurt their well yields. They have tried to modify their existing wells, but this has not allowed them to get the water they need, and have a right to. Drilling new wells in order to return their water supplies to pre-drawdown levels would be expensive, and may not work.

Effects on water supplies for dairy farms

Among the junior users drawing groundwater from the ESRPA are a number of wells serving dairy farms, mostly in the Magic Valley north of the Snake River. These are classified as agricultural water uses in spite of the industrial scale of most modern dairies. Some of these dairy wells would be in line to be shut down by a water call from the senior springflow users.

The dairies rely on feed (principally alfalfa hay and corn silage) from irrigated farms in the area -- some of which might also lose their water. The dairies also rely on nearby farms for places to dispose of manure. The question to be addressed is whether these dairies would be likely to shut down, or whether they could reasonably find alternative sources for water, feed, and manure disposal.

The Hazen-Ohlensehlen study developed two alternative scenarios. One scenario assumed that the junior dairies would shut down and that 40 thousand acres of junior cropland consisting entirely of alfalfa hay and corn silage would also be idled. Their second scenario assumed that the dairies could find alternative sources of water, that corn silage and hay would still be available as before although it might be grown on different farms, and that the cropland reductions would come from lower valued grain crops. My opinion is that something like the second scenario is the more likely.

The amount of water consumed by dairies is small compared to the water consumed by crops. A dairy farm needs about 35 gallons of water per cow per day. That means that one acre-foot of water would supply 25 cows for a year. Looked at another way, it means that the annual consumptive depletion by an acre of cropland is equal to the annual water needs of 42 dairy cows. If a 4,200 cow dairy were forced to seek an alternative more senior water right to transfer to the dairy, it would take about a hundred acres of transferred water right. There are a number of crop use to dairy use water transfers in various stages of consideration at the present time -- for example the proposed transfer now being considered in Lincoln County (The Times-News, August 30, 2004).

Economic Importance of ESRPA-Dependant Springflow

Consistent with the numbers above, Hazen and Ohlensehlen note that North Snake Groundwater District members report pumping 417,000 acre-feet, of which only 20,000 acre-feet or 4.8 percent is used by dairies. Finding an alternative water supply would be a significant cost, but should not be an insurmountable problem. It would mean that a water call would cut off not only the irrigated acreage supplied by the junior wells, but also an additional acreage corresponding to the water rights needed for transfer to the dairies. This means that the impacted crop acreage could be higher by about 5 percent than would be indicated by looking only at the irrigation well priority dates.

Other concerns are the effect that reductions in the crop acreage based on groundwater pumping will have on feed supplies for the dairies and on the availability of land for manure disposal. Appendix table A1, and the pie charts which follow, show that there are 133,000 acres of irrigated grain crops in Gooding, Jerome, Minidoka and Lincoln Counties. This implies that dried up alfalfa and corn silage crops could be shifted to lands presently growing other crops such as grain, as implied in the second scenario of the Hazen-Ohlensehlen study. The flexibility to do this is least in Gooding and Jerome Counties, where the density of dairies is greatest, since these two counties already grow a disproportionate amount of hay and silage, and less grain. Most likely, land closest to the dairies would emphasize corn silage production because it is most expensive to haul any distance. Corn silage might even replace some alfalfa production close to the dairies. Alfalfa hay production might shift further away, given its lower transportation cost. Again, while there would be a cost, the innate flexibility of southern Idaho irrigated agriculture to change crop mix and location when conditions change means that a shutdown of junior groundwater users should not deprive southern Idaho dairies of needed feed supplies.

A similar argument applies to the manure disposal issue, although the result probably depends on the particular circumstances of each affected dairy. Manure is expensive to haul any distance, so land disposal is limited to cropland near the dairy. In most cases disposal can probably be shifted to remaining cropland, perhaps with some increase in costs. In other cases alternative technologies such as composting may work. In a few cases manure disposal problems may prove critical and result in the shutdown of some dairies.

Hydropower Depending on Springflows

Since early in the last century any flowing or falling water has been an attractive target for hydropower development. Two types of hydropower projects are most relevant when thinking about springflow. First, there are a number of power projects which rely directly on springflow as it falls from the Snake River canyon walls to the river. Second, once the springwater reaches the river, it has the potential to flow through a series of hydropower projects downstream.

<u>Hydropower at springs</u>

The first hydropower project relying directly on Thousand Springs flow, built by Thousand Springs Power Company, began operation in 1912. A few years later this plant became the first of several spring-based powerplants feeding electricity into the Idaho Power Company (IPC) grid. The Thousand Springs powerplant produces about 60,000 mwh of power each year. The market price at which utilities are currently buying and selling electricity at the Mid Columbia Hub is about $0.045 per kwh (Lon Peters, Northwest Economic Research, Inc., personal communication), so the value of this power to IPC is about $2.7 million per year. IPC also has a tiny spring-powered plant at Clear Lakes which generated about 15,000 mwh per year, with a value of $675,000 per year.

> ## Box 4: Potential Hydropower Generation
>
> This section refers to "potential" hydropower value. This is the power that could be generated if the water is actually used to generate electricity at each of the dams it passes through. That may not actually happen. Some water may be spilled if there is no market for the power, or if the powerplant is already at capacity. Powerplant outages and maintenance schedules can also affect water use.
>
> These factors are most likely to reduce actual generation below potential generation in the central Snake region below American Falls and above CJ Strike where the powerplants are quite small. This is less of a factor at American Falls and at and below Brownlee. These powerplants have large hydraulic capacities, and have the storage capacity to shift water flows to times when the generation is needed.
>
> Some water is spilled to aid fish passage at lower Snake and Lower Columbia River Dams. However this spill amount is determined by policy, so marginal changes to flow from the upper Snake should not change the spill amount, and should all be usable for generation.

More recently, beginning in the 1970s, a number of independently owned small hydro projects based on springflows were constructed. These were stimulated by federal legislation that allowed small independently owned hydropower projects to connect into the supply grids of public utilities like IPC, and be paid on a net billing basis. Just two examples of such small hydropower plants are the Clear Springs Foods hydropower plant which uses the fall of water between the Box Canyon Springs and their trout farm to generate power, and the independently owned hydropower plant which uses the released water as it flows out of the trout farm and into the river. Power production at these small hydropower projects will be roughly proportional to springflow, meaning that as springflow declines below decreed water rights and powerplant capacities, so will electricity output, and so will power revenues to the various owners of these projects. The Clear Springs Foods powerplant is rated at 564 KW. If it operates 90 percent of the time at full capacity, it would produce 4,941 mwh of electricity with a value of $222,000 per year.

The two small hydropower plants using Box Canyon springwater are just two examples from some 16 small powerplants in the region that depend directly on flow from springs in the Thousand Springs reach (these small hydropower plants are listed in appendix Table A-5). If these 16 small hydropower plants operate at a 90 percent capacity factor, they can produce electricity valued at $11.8 million per year.

<u>Other small hydropower projects depending on springflow</u>

There are also a number of other small hydropower projects that depend somewhat less directly on springflows (these are also listed in Table A-5. These include a number of small hydropower plants located on canals within both the Twin Falls and North Side projects water delivery systems. As falling springflows reduce water supplies for the irrigation projects, the reduced canal flows will reduce power generation.

Several other small hydropower projects rely largely on runoff from irrigation projects – for example the projects on Rock Creek and the Malad River. Much of the water in these streams originally came from springflow, even though it has passed through an irrigation project. These small hydro projects will also suffer as declining flows from springs in the American Falls reach cause irrigation water supply shortages and provide incentives for irrigation efficiency improvements.

These small hydropower plants, most of which are located in irrigation systems that depend on water most of which originates from springflow, have water to operate only about one third of the time. Thus the 17 small plants in Table A-5 can, at a 33 percent capacity factor, generate electricity valued at $7.5 million per year.

Downstream hydropower

However, the Thousand Springs projects and the small hydro projects are not the most important power impacts of springflow. The more important impact comes from the hydropower generated by springflow at the bigger hydropower projects located on the river itself. There are a total of 22 hydropower plants located on the Snake and Columbia Rivers from American Falls Dam through Bonneville Dam. Appendix Table A-4 shows the developed head at each of these 22 powerplants. These 22 powerplants have a total developed head of 2,245 feet, so each acre-foot of water in American Falls Reservoir could potentially generate 1,953 kwh of power worth $87.89 if it were to flow all the way to the Pacific (Table A-5). Of this generation, 68 percent would occur at Idaho Power Company dams, and 32 percent at lower Snake and Columbia River dams.

It was indicated in Table 4 that springflow declines in the river reaches above Milner reduced the available water supplies by 1.5 maf. Some of this water would have been used for irrigation in most years. Some would have served as insurance against water shortage in dry years, but would have flowed downstream in many years where it could generate hydropower. There are no available models to show how that 1.5 maf would have been divided between irrigation use and hydropower use, if it had not been taken away by groundwater pumpers. If it had been allocated half to each, then the 750 kaf allocated to hydropower could have generated 1.46 million MWH worth $66 million as it passed the 22 downstream dams. Of this electricity, $45 million would have been generated at IPC dams and $21 million at federal dams.

Box 5: Swan Falls Trust Water

It may be useful to think about the effect that springflow declines have in conjunction with the minimum stream flows at Swan Falls Dam established by the Swan Falls Agreement. One possible interpretation is that much of the "Trust Water" that was designated for additional irrigation development has in fact been used up by groundwater development subsequent to the agreement. If this is a proper way to look at things, then the forgone benefits of not being able to develop this trust water are a cost of springflow decline imposed by groundwater pumpers.

Even if American Falls water is diverted for irrigation at Milner Dam, it still has the potential to generate some electricity. Springflows between Neeley and American Falls amount to some 1.6 maf annually, providing a significant part of the natural flow and storage water supplies of the Magic Valley irrigation projects. As this springwater is released for irrigation use, much of it is passed through IPC's powerplant at American Falls Dam and the Bureau of Reclamation (USBOR) powerplant at Minidoka Dam, before most of it is diverted at Milner. The cumulative hydropower head at American Falls and Minidoka Dams depends on the fill status of the reservoirs, but will average about 106 feet. Each acre foot of springwater in American Falls Reservoir could potentially generate 92 kwh of electricity at the two powerplants before being diverted for irrigation at Milner

Dam (Appendix Table A-4). At the $0.045 per kwh rate, the potential electricity generation from each acre-foot of springflow water flowing from American Falls Reservoir to Milner Diversion would have a value of $4.15. If most of the 1.6 maf of springflow from the American Falls reach is used for irrigation, it can generate about $6.6 million before it reaches the Milner Diversion. It also follows that as springflows decline at American Falls, it costs IPC and the USBOR $4.15 per acre-foot of decline.

Springwater originating in the Thousand Springs reach can, so long as it is not consumptively used, potentially pass through and generate electricity at seventeen downstream hydropower projects (Table A-5). Note that the most visible users of Thousand Springs water, the trout farms, actually consume very little of it. Most of what they use passes through their facilities undiminished to the river. The prime consumptive users of the Thousand Springs flows are the 5,500 acres of irrigated cropland near Hagerman, and the 177,500 acres of river pumpers downstream, but their use is a small part of total springflow. Because Thousand Springs is a bit lower in the system, with only seventeen dams and 1,638 feet of developed head downstream, unconsumed water from Thousand Springs could potentially generate $64.13 per acre-foot. Note that $27.80 per acre-foot of this potential hydropower would be generated at federal Snake and Columbia River powerplants, and $36.33 at IPC facilities. If the total amount of Thousand Springs water is 4.1 maf, and 10 kaf is consumptively used by irrigation at Hagerman and 355 kaf by irrigation at the high-lift river pumps, this leaves 3.7 maf that flows on down to the Pacific. This has a potential power value of $240 million per year -- $136 million at IPC dams and $104 million at federal dams.

Table 4 showed that springflows in the Thousand Springs reach declined by 473 kaf as a result of groundwater pumping. Because these declines had little effect on consumptive use in this reach, flows at all 17 downstream dams have decreased by this same amount. This has a potential power value impact of $30.3 million per year -- $17.2 million at IPC dams and $13.1 million at federal dams.

To summarize -- for each acre-foot that springflows decline, the potential hydropower losses are $4.15 for American Falls water if it is diverted for irrigation at Milner and $87.89 if it can flow all the way to the Pacific and $64.13 for Thousand Springs water if it can flow all the way to the Pacific. Note that considerable springflow declines have already occurred, so significant lost hydropower costs have already been incurred by IPC, other private powerplant owners, and by the federal power agencies.

Domestic, Commercial, Municipal and Industrial Uses Depending on Springflows

Twin Falls water supply concerns

The City of Twin Falls meets its municipal water demand with a water right at Blue Lakes in the Snake River Canyon and six municipal wells. The 26 mgd of Blue Lakes water originates in the ESRPA and is pumped through a single 30 inch diameter pipe 500 feet to the Canyon rim. The city's right would allow it to pump 32 mgd, but developing this additional water would be expensive ($1.7 million in 1997) and would stress the environmentally sensitive Blue Lakes area (Cosgrove, et. al., 1997). The city shares the Blue Lakes flows with several other users, including Blue Lakes Country Club. Tom Courtney, Twin Falls City Manager, reports that the springs which once ran at 200 cfs have for years been dropping at about ½ to 1 percent per year. More recently the decline has edged closer to 3 percent per year, dropping current Blue Lakes water flow to about 150 cfs

Economic Importance of ESRPA-Dependant Springflow

Faced with a rapidly growing population, Twin Falls is attempting to plan for future water needs. The city has chosen to use wells to meet demand growth, and now has six wells yielding 23.3 mgd. Unfortunately there are problems with moving much further in the direction of relying on well water. The first problem is water quality. Groundwater from parts of the local aquifer has arsenic levels too high to meet proposed drinking water standards, meaning that the well water would either have to be blended with Blue Lakes water or subjected to expensive water treatment. This means that a healthy ESRPA, with continued outflows of water at Blue Lakes is extremely important to the city's water supply.

The second problem is with water levels in the local south side aquifer. When the Twin Falls project started in the early 1900s, the resulting aquifer recharge raised the local water table by as much as 300 feet (Cosgrove, et. al., 1997). However, declining springflows in the Blackfoot to American Falls reach have forced both farmers and irrigation projects to increase the efficiency with which they convey and use water. While this has helped them to stretch the limited water supplies, it has also reduced the amount of water going to recharge the local aquifer. Cosgrove et. al. (1997) modeled a scenario where 30 percent of local irrigators convert to sprinkler application, and found water table declines of 40 to 70 feet over much of the area.

It should be pointed out that the Twin Falls water supply from municipal wells is also vulnerable to the health of the ESRPA. The cascading effects of groundwater pumping affect American Falls springflows – which affect Twin Falls project water supplies and irrigation practices – which affect groundwater levels in the Twin Falls local aquifer.

The Twin Falls city water system serves several significant industrial water users, the largest of which is a Lamb-Weston food processing plant. Fears about the future of the local water supply means that Twin Falls is not actively seeking, and might be reluctant to serve an additional large industrial water user. Clearly, water supply concerns are an impediment of the economic development of the city.

Small town and rural water supply impacts of aquifer decline

Nearly all of the small towns and rural residences in southern Idaho depend on wells for their water supplies. While there are more domestic wells than there are irrigation wells, the domestic wells are mostly much smaller than the irrigation wells, so the volume of domestic pumping is much smaller. DCMI water is given a priority above irrigation in the Idaho Constitution, so shutting off junior priority domestic wells is not an issue.

However, just like the senior irrigation groundwater users, these domestic groundwater users are being hurt by aquifer declines caused by the junior irrigation pumpers. The annual power cost increase by about 7 cents per acre-foot for each foot of groundwater decline is not likely to be noticed by most small town and rural residential users. However, in cases where groundwater decline means that rural residential wells must be deepened, or pumps modified or where small town water systems experience well yield declines so that another well must be drilled, the costs may be considerable.

Recreation Uses Depending on Springflows

It is common knowledge that springflows, especially those at Thousand Springs do provide recreation benefits. However it is extremely hard to attach a dollar value to that recreation. Recreation activities that have a significant link to springflows include fishing, boating, camping, wildlife viewing, and simply enjoying the unique scenery of the Snake River Canyon. There are several golf courses in the canyon, and these depend on water supplies linked to the ESRPA. The visitor days that these recreation activities generate and the dollars they bring into the local economies are certain to be significant. There are three Idaho State parks dependent on spring flows in the Magic Valley area (Three Island Crossing, Malad Gorge and Niagra Springs). There is a federal wildlife refuge (Minidoka), three state wildlife management areas (Niagra Springs, Hagerman and Billingsley Creek), and one state nature preserve (Earl Hardy Box Canyon Nature Preserve) dependent on spring water flows. These activities and the local economies that depend on them will be further damaged if springflow decline continues.

This report discussed the IDFG and IPC fish farms above, under the aquaculture section. It is sufficient to note here that these facilities produce trout and steelhead for release, which contributes very significantly to recreational fishing in this region and in the state.

Environmental and Endangered Species Concerns

The environmental and endangered species issues related to springflow decline are even harder to attach a dollar value to than the recreation issues. The Snake River between Milner and Bliss is an especially sensitive area. Since nearly the entire remaining water flow is often diverted at Milner, the river below Milner is regularly starved for flow. This reach of the river has been plagued by aquatic plant (algae and rooted macrophytes) blooms fueled by agricultural return flows and effluent from municipalities and fish farms, although waste management practices have all improved in recent years. The absence of regular spring flushing flows, because water is stored upstream for irrigation and because groundwater pumping has reduced upstream springflows, significantly contributes to the problem.

This reach of the river is home to five listed species of snails and limpets, and is home to a remnant population of white sturgeon, which is not listed, but is certainly scarce. Further declines in flows and reductions in spring flushing of the river will certainly harm these species.

One of the listed snails resides in Box Canyon, above the point where Clear Springs Foods diverts water for its largest production facility. Clear Springs Foods has a water right for 300 cfs from Box springs and both their production facility and their small hydropower plant are designed for this 300 cfs flow. Until recently flows from Box Canyon Springs have been well above the 300 cfs level, but in July 2004 springflows dropped to 306 cfs.

Listed salmon species are, of course, the biggest ESA issue in the Pacific Northwest. In recent years, Idaho has committed to providing 427,000 kaf of water for flow supplementation in the summer. This 427 kaf has come from rental pool purchases, unallocated storage, and from long-term lease or outright purchase of water rights. If springflows decline at American Falls, this means less water flowing naturally downstream from Milner to help salmon flows, and less unneeded water left in storage owned by Magic Valley irrigation projects, thus less water consigned to the rental pool, and less rental pool water available for salmon. When rental pool water has been available, it has been a relatively low cost and painless way to meet the 427 kaf commitment. When rental pool water is not available, more costly water must be found to meet the commitment.

FURTHER COMMENTS ON MODELING ECONOMIC IMPACTS OF SPRINGFLOW AND CURTAILMENT SCENARIOS

This report has focused on the total value of output attributable to springflow and changes in flow. It has not tried to translate these effects into income or employment effects, or to model the distribution of these effects across various sectors of the Idaho economy. No economic model that would accurately do this presently exists, and building such a model was beyond the scope of this analysis. The Magic Valley model used by Hazen and Ohlensehlen was an appropriate model given the very limited conceptualization of their study, where they cast the issue as one of trout farms versus dairies and crop farms using groundwater, and viewed the economic effects as limited to the Magic Valley.

This report has shown that the effects of springflow decline go far beyond the Magic Valley economy that they modeled, and involve many other economic sectors in addition to trout farms and dairy/crop groundwater users. Some of the proposals for dealing with conjunctive use water issues would have significant statewide impacts, significant distributional issues, and state general fund effects. Hazen and Ohlensehlen's Magic Valley model is not comprehensive enough to serve the purpose of modeling these extensive and diverse economic and fiscal effects. While building a comprehensive Idaho-wide economic model to assess the economic impacts of water legislation was beyond the scope of this study, building such a model would be helpful.

While a more comprehensive Idaho-wide economic model would be helpful, it is unlikely to significantly alter the economic conclusions offered in this report. The multipliers from the Hazen and Ohlensehlen Magic Valley model shown in Table 8 are suggestive of what the results would be if we actually had the comprehensive model to translate sector outputs into income and employment effects. The multipliers produced by a comprehensive Idaho model would most likely be somewhat larger, since they would include economic activity generated outside the Magic Valley, but inside Idaho. While there are some differences between the income multipliers and employment multipliers for the sectors most likely to be affected by water policy decisions, the differences are not large. Given the uncertainty of the procedures used to estimate these multipliers in a model such as the Magic Valley model, it is not even clear how much of these differences is real and how much is due to data, aggregation, and other methodological problems.

Table 8: Selected Multipliers from Magic Valley Model

	Employment Multiplier (Change in jobs per $million change in exports)	Income Multiplier ($ income per $million change in exports)
Dairy Farming	17.35	474,735
Fish Farming	27.81	328,665
Food Grain Production	24.89	326,729
Feed Grain Production	19.45	362,768
Milk and Cheese Processing	17.09	460,059
Fresh or Frozen Fish Processing	23.06	408,386
Transport, Communication & Utilities	15.63	454,843

Source: Magic Valley Model, Ag Econ Department, U of I, 2004.

Economic Importance of ESRPA-Dependant Springflow

The bottom line is that even if one had a good comprehensive Idaho economic model, it would probably not make much difference in the conclusions of this study. Even with a better economic model and better multipliers, the relative economic importance of the sectors most likely to be impacted – springflow based agriculture, agriculture based on groundwater, aquaculture, and hydropower – probably wouldn't change.

What a more comprehensive Idaho model could provide would be a better estimate of the distribution of the impacts of any water policy changes across the regions of the state, across the sectors of the state economy, and to the state's general fund. For these purposes a state model would be desirable.

Models to estimate Economic Effects of Groundwater Curtailment

While it might be tempting to try to extend the results of this report to try to draw conclusions about the benefits and costs of a curtailment scenario, it is probably premature to do so. No curtailment scenario has yet been well fleshed out. There is as yet no agreement what groundwater pumpers (which region and what priority cutoff date) it would apply to. There is no agreement whether it would be implemented by fiat or on a willing seller basis, whether curtailment would be permanent or for a term, whether it would require cessation of pumping or whether some form of mitigation would be acceptable. There is no agreement who would pay for the program, state taxpayers, a fee on wells, a federal-state Conservation Reserve Enhancement Program, or the curtailed farmers themselves. Further, since there is no agreed on scenario, there has been no analysis of the hydrologic effects of such a scenario using the new ESRPA model.

In order to proceed with an analysis of a particular curtailment program we would first need the hydrologic results. Then to do the economic analysis we would need models to show how the curtailed farmers and the remaining irrigators would respond. Such models would need to be built. We would also need models to show how springwater users would respond if flows are increased or actually restored. These models also do not exist at present. Third, we would need models that can show how these changes in production patterns translate into changes in income, and into fiscal impacts for the state budget. The model used by Hazen and Ohlensehlen is a start in this direction, but would need to be augmented to serve this purpose. The state is apparently in the process of expanding this model, which is a useful step.

In time, if the state is serious about developing policies to address the conjunctive use problems in the Snake River Basin, is would be appropriate to develop the needed models and to do the required economic analysis for the range of policy alternatives under consideration.

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http://www.efw.bpa.gov/EW/EWP/DOCS/REPORTS/HATCHERY/IHOT/magicvalleyhatchery1-1996.pdf
http://www.webs.uidaho.edu/aquaculture/u_of_i_hagerman.asp

Table A - 1: Acres of Major Crops, By County

Source	Bannock	Bingham	Blaine	Bonne-ville	Cassia	Gooding	Jefferson	Jerome	Lincoln	Minidoka	Power	Twin Falls	Lower 4 County (N) Total	Lower 6 County (N&S)Total	Upper 5 County Total	9 Counties North of Snake	All 12 Counties
Irrigated Alfalfa Harvested Acres																	
1998 IASS	14,200	55,700	15,100	22,900	54,600	37,300	93,400	41,900	17,200	27,400	8,200	71,400	123,800	249,800	195,300	333,300	459,300
1999 IASS	13,900	59,300	17,400	28,000	55,100	41,200	94,800	46,200	18,900	27,100	8,500	65,700	133,400	254,200	208,000	355,300	476,100
2000 IASS	12,800	50,000	16,800	24,600	46,400	38,800	98,400	48,000	18,200	25,400	7,700	67,100	130,400	243,900	197,500	340,700	454,200
2001 IASS	12,700	51,700	17,600	24,700	50,100	33,500	90,000	48,500	17,000	26,300	9,200	67,000	125,300	242,400	193,200	331,200	448,300
2002 IASS	16,600	66,000	18,300	25,500	63,500	40,200	106,000	49,500	17,500	34,000	10,700	75,000	141,200	279,700	226,500	384,300	522,800
2003 IASS	14,500	63,900	17,000	27,400	56,900	30,000	99,700	41,600	23,300	28,400	9,300	70,900	123,300	251,100	217,300	365,100	482,900
Average:	14,117	57,767	17,033	25,517	54,433	36,833	97,050	45,950	18,683	28,100	8,933	69,517	129,567	253,517	206,300	349,963	473,933
	28.9%	17.7%	35.6%	17.0%	20.7%	31.7%	46.7%	31.3%	26.8%	14.8%	7.6%	26.8%	24.8%	24.2%	24.3%	24.6%	24.4%
Irrigated Wheat Harvested Acres																	
1998 IASS	9,600	124,500	1,800	38,400	74,800	10,300	52,600	22,200	12,300	46,900	53,900	39,400	91,700	205,900	271,200	372,500	486,700
1999 IASS	11,700	126,100	2,200	43,500	76,900	7,400	59,100	20,100	12,400	55,000	63,900	31,500	94,900	203,300	294,600	401,400	509,800
2000 IASS	12,200	132,200		38,600	79,800	8,600	36,700	18,300	12,000	44,700	59,200	35,200	83,600	198,600	266,700	362,500	477,500
2001 IASS	13,300	113,600		30,300	69,000	6,000	30,900	11,100	7,700	27,600	54,000	25,800	52,400	147,200	228,800	294,500	389,300
2002 IASS	14,800	115,100		30,600	62,700		27,200	11,600		32,600	51,400	26,700	44,200	133,600	224,300	283,300	372,700
2003 IASS	11,400	114,800		25,200	72,399	6,200				29,600	58,000		35,800	108,199	198,000	245,200	317,599
Average:	12,167	121,050	2,000	34,433	72,600	7,700	41,300	16,660	11,100	39,400	56,733	31,720	67,100	166,133	247,300	326,567	425,600
	24.9%	37.1%	4.2%	22.9%	27.6%	6.6%	19.9%	11.3%	15.9%	20.7%	48.3%	12.2%	12.8%	15.9%	29.1%	23.0%	21.9%
Irrigated Sugarbeet Harvested Acres																	
1998 IASS		20,700	1,600		36,400	5,200		15,000	8,300	44,100	15,700	17,900	72,600	126,900	38,000	110,600	164,900
1999 IASS		22,900			37,200	4,200		15,500	9,200	44,700	14,100	18,500	73,600	129,300	37,000	110,600	166,300
2000 IASS		21,900			34,600	4,500		12,400	6,900	41,200	12,700	15,200	65,000	114,800	34,600	99,600	149,400
2001 IASS		21,300			33,600	4,900		14,300	6,700	40,900	14,200	14,900	66,800	115,300	35,500	102,300	150,800
2002 IASS		25,200	1,500		38,100	3,700		16,800	8,200	44,000	12,600	18,200	72,700	129,000	39,300	112,000	168,300
2003 IASS		23,300			37,200	3,700		15,900	4,500	51,500	13,900	16,600	75,600	129,400	37,200	112,800	166,600
Average:		22,550	1,550		36,183	4,367		14,983	7,300	44,400	13,867	16,883	71,050	124,117	36,933	107,983	161,050
		6.9%	3.2%		13.8%	3.8%		10.2%	10.5%	23.3%	11.8%	6.5%	13.6%	11.9%	4.3%	7.6%	8.3%
Irrigated Potatoes Harvested Acres																	
1998 IASS	4,500	63,500	2,000	31,600	33,800	13,900	32,900	15,900	5,000	25,400	34,800	19,500	60,200	113,500	164,800	229,500	282,800
1999 IASS	4,500	63,600	2,000	31,800	33,800	8,200	29,900	14,900	6,000	27,800	33,800	16,200	56,900	106,900	161,100	222,500	272,500
2000 IASS	5,200	67,000	2,000	29,800	35,300	6,800	30,900	15,600	6,000	30,200	36,700	19,000	60,600	114,900	166,400	232,200	286,500
2001 IASS	3,700	55,200	1,300	28,700	29,800	4,900	29,600	11,300	1,500	30,300	33,400	14,400	48,000	92,200	148,200	199,900	244,100
2002 IASS	3,500	59,700	1,400	31,200	30,100	5,800	36,700	10,700	1,800	31,700	36,800	15,800	50,000	95,900	165,800	219,300	265,200
2003 IASS																	
Average:	4,280	61,800	1,740	30,620	32,560	8,320	32,000	13,680	4,060	29,080	35,100	16,980	55,140	104,680	161,260	220,680	270,220
	8.8%	19.0%	3.6%	20.4%	12.4%	7.2%	15.4%	9.3%	5.8%	15.3%	29.9%	6.5%	10.5%	10.0%	19.0%	15.5%	13.9%
Irrigated Corn Harvested for Grain Acres																	
1998 IASS					300	7,300		2,800	500			8,100	10,600	19,000	0	10,600	19,000
1999 IASS					500	5,600		1,800	300			8,200	7,700	16,400	0	7,700	16,400
2000 IASS		200			300	3,200		2,700	600		1,600	8,600	6,500	15,400	1,600	6,300	17,200
2001 IASS				200	1,300	4,500		3,100	500		2,900	6,500	8,100	15,900	3,100	11,200	19,000
2002 IASS					200	4,200		1,100	300	200		3,300	5,800	9,300	0	5,800	9,300
2003 IASS						6,900		3,500	900			3,500	11,300	14,800	0	11,300	14,800
Average:		200		200	520	5,283		2,500	517	200	2,250	6,367	8,333	15,133	817	9,150	15,950
		0.1%		0.1%	0.2%	4.5%		1.7%	0.7%	0.1%	1.9%	2.5%	1.6%	1.4%	0.1%	0.6%	0.8%

Hamilton
Water Economics

Table A - 1: Acres of Major Crops, By County (continued)

Source	Bannock	Bingham	Blaine	Bonneville	Cassia	Gooding	Jefferson	Jerome	Lincoln	Minidoka	Power	Twin Falls	Lower 4 County (N) Total	Lower 6 County (N&S) Total	Upper 5 County Total	9 Counties North of Snake	All 12 Counties
Irrigated Corn Harvested for Silage Acres																	
1998 IASS					7,800	16,300	2,900	12,600	3,600	1,700		14,100	34,200	56,100	2,900	37,100	59,000
1999 IASS		1,200			8,500	16,800	2,800	17,000	4,600	2,400		15,700	40,800	65,000	4,000	44,800	69,000
2000 IASS		1,800		1,900	12,400	16,500	3,600	22,600	5,300	3,400	1,500	18,900	47,800	79,100	8,800	56,600	87,900
2001 IASS		2,000		1,700	10,900	20,300	3,300	23,200	3,400	2,900	100	17,700	49,800	78,400	7,100	56,900	85,500
2002 IASS		3,200		2,400	12,700	32,800	3,400	19,000	3,900	3,000		19,800	58,700	91,200	9,000	67,700	100,200
2003 IASS		2,300				23,400	4,200	22,600	3,000			20,800	49,000	69,800	6,500	55,500	76,300
Average:		2,100		2,000	10,460	21,017	3,367	19,500	3,967	2,680	800	17,833	46,717	73,267	6,383	53,100	79,650
		0.6%		1.3%	4.0%	18.1%	1.6%	13.3%	5.7%	1.4%	0.7%	6.9%	8.9%	7.0%	0.8%	3.7%	4.1%
Irrigated Barley Harvested Acres																	
1998 IASS	4,700	21,000	18,700	48,300	27,000	3,800	47,100	12,900	10,100	34,300	2,900	31,800	61,100	119,900	138,000	203,800	262,600
1999 IASS	4,800	20,100	19,600	44,400	25,800	2,200	42,000	12,100	9,600	32,400	2,800	31,600	56,300	113,700	127,900	189,000	246,400
2000 IASS	4,900	22,500	18,300	46,200	24,700	3,800	48,800	17,700	10,700	39,100	2,600	37,600	71,300	133,600	138,400	214,600	276,900
2001 IASS	2,800	18,900	11,200	48,600	25,600	1,900	41,600	17,900	5,200	39,900	3,700	35,400	64,900	125,900	124,000	191,700	252,700
2002 IASS	2,600		11,500	53,900	26,700	2,200	42,700	23,100		38,900	7,300		64,200	90,900	115,400	182,200	208,900
2003 IASS	3,200		13,300	61,300		2,900		22,900			7,400		25,800	25,800	82,000	111,000	111,000
Average:	3,833	20,625	15,267	50,450	25,960	2,800	44,440	17,767	8,900	36,920	4,450	34,100	57,267	101,633	120,950	182,050	226,417
	7.8%	6.3%	31.9%	33.5%	9.9%	2.4%	21.4%	12.1%	12.8%	19.4%	3.8%	13.1%	11.0%	9.7%	14.2%	12.8%	11.6%
Irrigated Dry Beans Harvested Acres																	
1998 IASS					4,800	1,700		13,000		7,800		42,200	22,500	69,500	0	22,500	69,500
1999 IASS					7,200	2,100		13,100		8,200	800	36,200	23,400	66,800	800	24,200	67,600
2000 IASS					4,400	900		8,300		5,100	900	29,400	14,300	48,100	900	15,200	49,000
2001 IASS					4,200	500		7,200	500	4,300		18,100	12,500	34,800	0	12,500	34,800
2002 IASS					6,100	1,100		12,400	1,100	6,200		31,800	20,800	58,700	0	20,800	58,700
2003 IASS					6,100	700		11,300	700	5,800		25,000	18,500	49,600	0	18,500	49,600
Average:					5,467	1,167		10,883	767	6,233	850	30,450	18,667	54,583	283	18,950	54,867
					2.1%	1.0%		7.4%	1.1%	3.3%	0.7%	11.7%	3.6%	5.2%	0.0%	1.3%	2.8%
Irrigated Pasture & Other																	
1997 Ag Census	6,665	21,999	14,129	10,378	15,722	15,752	12,407	10,326	12,328	7,278	1,537	21,433	45,684	82,839	60,450	112,799	149,954
2002 Ag Census	8,393	24,817	11,485	10,167	14,168	17,568	13,335	8,993	18,100	4,822	13,799	22,851	49,483	86,502	73,603	131,479	168,498
Average:	7,529	23,408	12,807	10,273	14,945	16,660	12,871	9,660	15,214	6,050	7,668	22,142	47,584	84,671	67,027	122,139	159,226
	15.4%	7.2%	26.7%	6.8%	5.7%	14.3%	6.2%	6.6%	21.8%	3.2%	6.5%	8.5%	9.1%	8.1%	7.9%	8.6%	8.2%
Total of Selected Crops Listed Above																	
	41,926	309,500	50,397	153,493	253,128	104,147	231,028	151,583	70,507	193,063	130,651	245,992	519,300	1,018,420	875,068	1,436,294	1,935,414
Irrigated Acres																	
1997 Ag Census	42,598	329,186	55,322	159,095	263,847	114,718	213,374	154,001	72,973	183,169	121,168	280,960	524,861	1,069,668	878,145	1,445,604	1,990,411
2002 Ag Census	55,177	322,801	40,474	141,823	262,249	117,586	202,620	139,908	66,362	197,243	113,698	238,320	521,099	1,021,668	821,416	1,397,692	1,898,261
Average:	48,888	325,994	47,898	150,459	263,048	116,152	207,997	146,955	69,668	190,206	117,433	259,640	522,980	1,045,668	849,781	1,421,648	1,944,336
Irrigated Crops Harvested																	
1997 Ag Census	35,933	307,187	41,193	148,717	248,125	98,966	200,967	143,675	60,645	175,891	119,631	259,527	479,177	986,829	817,695	1,332,805	1,840,457
2002 Ag Census	46,784	297,984	28,989	131,656	248,081	100,018	189,285	130,915	48,262	192,421	99,899	215,469	471,616	935,166	747,813	1,266,213	1,729,763
Average:	41,359	302,586	35,091	140,187	248,103	99,492	195,126	137,295	54,454	184,156	109,765	237,498	475,397	960,998	782,754	1,299,509	1,785,110
Market Value of Crops Sold																	
2002 Ag Census	23,982	197,963	8,387	89,478	143,604	35,090	99,528	75,279	15,329	145,277	79,477	107,421	270,975	522,000	474,833	769,790	1,020,815
Value/Acre	490.55	607.26	175.10	594.70	545.92	302.10	478.51	512.26	220.03	763.79	676.79	413.73	518.14	499.20	558.77	541.48	525.02

Hamilton
Water Economics

Economic Importance of ESRPA-Dependant Springflow

Table A - 2: Major Water Rights Sorted by User & Date
(For Projects From American Falls Through Milner)

Larson Modsim Number	District	Source	Amount	Priority or Refill Date
668	Falls Irrigation Dist	Natural Flow	125 cfs	4/1/1939
669	Falls Irrigation Dist	American Falls 2	22,925 acre-feet	3/31/1921 refill
670	Falls Irrigation Dist	Palisades 2	40,900 acre-feet	7/28/1939 refill
677	Minidoka Irrigation Dist	Natural Flow	1,726 cfs	3/26/1903
683	Minidoka Irrigation Dist	Natural Flow	1,000 cfs	8/6/1908
684	Minidoka Irrigation Dist	Natural Flow	430 cfs	4/1/1939
678	Minidoka Irrigation Dist	Jackson 1	127,040 acre-feet	8/23/1906 refill
679	Minidoka Irrigation Dist	Jackson 2	58,990 acre-feet	8/18/1910 refill
680	Minidoka Irrigation Dist	Palisades 1	8,000 acre-feet	3/29/1921 refill
681	Minidoka Irrigation Dist	American Falls 2	237,618 acre-feet	3/31/1921 refill
682	Minidoka Irrigation Dist	Palisades 2	66,200 acre-feet	7/28/1939 refill
685	Twin Falls Southside	Natural Flow	3,000 cfs	10/11/1900
689	Twin Falls Southside	Natural Flow	600 cfs	12/22/1915
690	Twin Falls Southside	Natural Flow	180 cfs	4/1/1939
686	Twin Falls Southside	Jackson 3	97,191 acre-feet	5/24/1913 refill
687	Twin Falls Southside	American Falls 1	147,581 acre-feet	3/29/1921 refill
688	Twin Falls Southside	American Falls 2	1,166 acre-feet	3/31/1921 refill
691	A & B Irrigation District	Natural Flow	267 cfs	4/1/1939
692	A & B Irrigation District	American Falls 2	46,826 acre-feet	3/31/1921 refill
693	A & B Irrigation District	Palisades 2	50,800 acre-feet	7/28/1939 refill
694	Milner-Gooding	Natural Flow	850 cfs	3/30/1921
695	Milner-Gooding	Natural Flow	1,700 cfs	4/1/1921
696	Milner-Gooding	American Falls 2	393,550 acre-feet	3/31/1921 refill
697	Twin Falls Northside	Natural Flow	400 cfs	10/11/1900
702	Twin Falls Northside	Natural Flow	2,250 cfs	10/7/1905
703	Twin Falls Northside	Natural Flow	350 cfs	6/16/1908
704	Twin Falls Northside	Natural Flow	300 cfs	12/23/1915
705	Twin Falls Northside	Natural Flow	1,260 cfs	8/6/1920
698	Twin Falls Northside	Jackson 3	312,007 acre-feet	5/24/1913 refill
700	Twin Falls Northside	American Falls 1	9,247 acre-feet	3/29/1921 refill
699	Twin Falls Northside	Palisades 1	116,600 acre-feet	3/29/1921 refill
701	Twin Falls Northside	American Falls 2	322,044 acre-feet	3/31/1921 refill
706	Milner Low Lift	Natural Flow	135 cfs	11/14/1916
709	Milner Low Lift	Natural Flow	121 cfs	4/1/1939
710	Milner Low Lift	Natural Flow	37 cfs	10/25/1939
711	Milner Low Lift	Natural Flow	14 cfs	4/26/1966
707	Milner Low Lift	American Falls 2	44,951 acre-feet	3/31/1921 refill
708	Milner Low Lift	Palisades 2	44,500 acre-feet	7/28/1939 refill

Source: Roger Larson, US Bureau of Reclamation, Modsim Model of Upper Snake River, Personal Communication

Hamilton
Water Economics

Economic Importance of ESRPA-Dependant Springflow

Table A - 3: Major Water Rights Sorted by Source & Date
(For Projects From American Falls Through Milner)

Larson Modsim Number	District	Source	Amount	Priority or Refill Date
	Flow Rights Below American Falls			
685	Twin Falls Southside	Natural Flow	3,000 cfs	10/11/1900
697	Twin Falls Northside	Natural Flow	400 cfs	10/11/1900
677	Minidoka Irrigation Dist	Natural Flow	1,726 cfs	3/26/1903
702	Twin Falls Northside	Natural Flow	2,250 cfs	10/7/1905
703	Twin Falls Northside	Natural Flow	350 cfs	6/16/1908
683	Minidoka Irrigation Dist	Natural Flow	1,000 cfs	8/6/1908
689	Twin Falls Southside	Natural Flow	600 cfs	12/22/1915
704	Twin Falls Northside	Natural Flow	300 cfs	12/23/1915
706	Milner Low Lift	Natural Flow	135 cfs	11/14/1916
705	Twin Falls Northside	Natural Flow	1,260 cfs	8/6/1920
694	Milner-Gooding	Natural Flow	850 cfs	3/30/1921
695	Milner-Gooding	Natural Flow	1,700 cfs	4/1/1921
668	Falls Irrigation Dist	Natural Flow	125 cfs	4/1/1939
684	Minidoka Irrigation Dist	Natural Flow	430 cfs	4/1/1939
690	Twin Falls Southside	Natural Flow	180 cfs	4/1/1939
691	A & B Irrigation District	Natural Flow	267 cfs	4/1/1939
709	Milner Low Lift	Natural Flow	121 cfs	4/1/1939
710	Milner Low Lift	Natural Flow	37 cfs	10/25/1939
711	Milner Low Lift	Natural Flow	14 cfs	4/26/1966
			14,745 cfs	
	Storage Rights in American Falls			
687	Twin Falls Southside	American Falls 1	147,581 acre-feet	3/29/1921 refill
700	Twin Falls Northside	American Falls 1	9,247 acre-feet	3/29/1921 refill
669	Falls Irrigation Dist	American Falls 2	22,925 acre-feet	3/31/1921 refill
681	Minidoka Irrigation Dist	American Falls 2	237,618 acre-feet	3/31/1921 refill
688	Twin Falls Southside	American Falls 2	1,166 acre-feet	3/31/1921 refill
692	A & B Irrigation District	American Falls 2	46,826 acre-feet	3/31/1921 refill
696	Milner-Gooding	American Falls 2	393,550 acre-feet	3/31/1921 refill
701	Twin Falls Northside	American Falls 2	322,044 acre-feet	3/31/1921 refill
707	Milner Low Lift	American Falls 2	44,951 acre-feet	3/31/1921 refill
			1,225,908 acre-feet	
	Other Storage Rights Held By Projects			
678	Minidoka Irrigation Dist	Jackson 1	127,040 acre-feet	8/23/1906 refill
679	Minidoka Irrigation Dist	Jackson 2	58,990 acre-feet	8/18/1910 refill
686	Twin Falls Southside	Jackson 3	97,191 acre-feet	5/24/1913 refill
698	Twin Falls Northside	Jackson 3	312,007 acre-feet	5/24/1913 refill
680	Minidoka Irrigation Dist	Palisades 1	8,000 acre-feet	3/29/1921 refill
699	Twin Falls Northside	Palisades 1	116,600 acre-feet	3/29/1921 refill
670	Falls Irrigation Dist	Palisades 2	40,900 acre-feet	7/28/1939 refill
682	Minidoka Irrigation Dist	Palisades 2	66,200 acre-feet	7/28/1939 refill
693	A & B Irrigation District	Palisades 2	50,800 acre-feet	7/28/1939 refill
708	Milner Low Lift	Palisades 2	44,500 acre-feet	7/28/1939 refill

Source: Roger Larson, US Bureau of Reclamation, Modsim Model of Upper Snake River, Personal Communication

Hamilton Water Economics

Economic Importance of ESRPA-Dependant Springflow

Table A-4: Potential Value of Columbia-Snake Basin Water for Hydropower

	At Each Dam:			Cumulative Downstream:		
	Developed Head feet	Potential Generation kwh / af [1]	Value at $0.045/kwh	Developed Head feet	Potential Generation kwh / af [1]	Value at $0.045/kwh
Lower Columbia						
Bonneville	59	51	$2.31	59	51	$2.31
The Dalles	83	72	$3.25	142	124	$5.56
John Day	100	87	$3.92	242	211	$9.47
McNary	74	64	$2.90	316	275	$12.37
Upper Columbia						
Priest Rapids	77	67	$3.01	393	342	$15.39
Wanapum	77	67	$3.01	470	409	$18.40
Rock Island	34	30	$1.33	504	438	$19.73
Rocky Reach	87	76	$3.41	591	514	$23.14
Wells	67	58	$2.62	658	572	$25.76
Chief Joseph	167	145	$6.54	825	718	$32.30
Grand Coulee	342	298	$13.39	1,167	1,015	$45.69
Upper Snake						
Ice Harbor	98	85	$3.84	414	360	$16.21
Lower Monumental	100	87	$3.92	514	447	$20.12
Little Goose	98	85	$3.84	612	532	$23.96
Lower Granite	98	85	$3.84	710	618	$27.80
Hells Canyon	210	183	$8.22	920	800	$36.02
Oxbow	120	104	$4.70	1,040	905	$40.72
Brownlee	272	237	$10.65	1,312	1,141	$51.36
Swan Falls	26	23	$1.02	1,338	1,164	$52.38
C.J. Strike	88	77	$3.45	1,426	1,241	$55.83
Bliss	70	61	$2.74	1,496	1,302	$58.57
Lower Salmon Falls	59	51	$2.31	1,555	1,353	$60.88
Upper Salmon Falls A	46	40	$1.80	1,601	1,393	$62.68
Upper Salmon Falls B	37	32	$1.45	1,638	1,425	$64.13
Shoshone Falls	214	186	$8.38	1,852	1,611	$72.51
Twin Falls	147	128	$5.76	1,999	1,739	$78.26
Milner - TFCC [2]	140	122	$5.48	2,139	1,861	$83.74
Minidoka	48	42	$1.88	2,187	1,903	$85.62
American Falls	58	50	$2.27	2,245	1,953	$87.89

Footnotes:

[1] These hydropower amounts are based on physical relationships and typical plant efficiencies, where an acre foot of water falling through a foot of developed head can generate about 0.87 kilowatt-hours of electricity. This assumes that the powerplants have capacity to handle the changed flow. In the long run, of course, capacity can be changed.

[2] This is based on power generation at the powerplant on the TFCC canal about a mile below the diversion at Milner Dam. The smaller powerplant located at Milner Dam would generate less power.

Hamilton
Water Economics

Table A-5: Small Hydropower Facilities Depending on Water from Eastern Snake Plain Aquifer

Location	Owner	Plant Name	Capacity (kW)
Hydropower Plants Depending Directly on Springflow			
WENDELL	BLIND CANYON AQUARANCH INC.	BLIND CANYON	1,300
	CLEAR SPRINGS FOODS INC.	BOX CANYON	564
	INTERMOUNTAIN HYDRO L.C.	BRIGGS	300
	KASTER, RICHARD	BRIGGS CREEK	750
BUHL	IDAHO POWER CO.	CLEAR LAKE	2,500
FILER	CRYSTAL SPRINGS HYDROELECTRIC	CRYSTAL SPRINGS	2,300
GOODING	FISHERIES DEVELOPMENT CO.	FISHERIES DEVELOPMENT	249
GOODING	CHI ENERGY, INC. (NOTCH BUTTE HYDRO CO)	GEO-BON II (NOTCH BUTTE HYDRO CO)	1,100
TWIN FALLS	K-W CO.	K-W HYDRO	1,000
	LEMOYNE, JOHN R.	LEMOYNE	75
HAGERMAN	IDAHO POWER CO.	LOWER MALAD	13,500
	RIM VIEW TROUT CO.	Rim View	300
	RIM VIEW TROUT CO.	RIM VIEW TROUT CO.	525
	SNAKE RIVER POTTERY	SNAKE RIVER POTTERY	86
WENDELL	IDAHO POWER CO.	THOUSAND SPRINGS	8,800
		Total (kw)	33,349
Hydropower Plants Depending Indirectly on Springflow			
Plants in Twin Falls Canal Company System			
BUHL	CRYSTAL SPRINGS HYDROELECTRIC (J&R ENERGY)	CEDAR DRAW CREEK (LITTLE MAC)	1,200
BUHL	LATERAL 10 VENTURES	LATERAL #10	2,400
HANSEN	IDA-WEST ENERGY/TWIN FALLS CANAL CO. (SOUTH FORKS JOINT VENTURE)	LOW LINE CANAL DROP (SOUTH FORKS HYDRO)	8,000
	CHI ENERGY, INC.	LOW-LINE RAPIDS	2,800
	LS LQ HYDROELECTRIC PARTNERS	LQ LS HYDRO	1,750
TWINS FALLS	CHI ENERGY, INC.	ROCK CREEK I	2,200
TWIN FALLS	SNEDIGAR DAVID AND ROBERT	SNEDIGAR RANCH	485
	MUD CREEK HYDRO INC.	WHITE RANCH	150
		Total (kw)	18,985
Plants in Northside Canal Company System			
JEROME	SITHE ENERGIES	BYPASS	9,900
JEROME	SITHE ENERGIES (SE HAZELTON A LTD PARTNERSHIP)	HAZELTON A	8,700
HAZELTON	IDA-WEST ENERGY/L.B. INDUSTRIES	HAZELTON B	7,600
	KASTER, RICHARD	KASTER RIVERVIEW	300
JEROME	MARCO RANCH HYDRO (HYDRO I INC.)	N-32 CANAL (HYDRO I INC.)	1,200
	RAVENSCROFT VERNON F.	RAVENSCROFT RANCH	1,063
EDEN	IDA-WEST ENERGY/L.B. INDUSTRIES (WILSON POWER CO.0	WILSON LAKE HYDRO	8,400
		Total (kw)	37,163
Plants in Milner-Gooding Canal Company System			
	SHOROCK HYDRO INC.	SHOSHONE	370
	SHOROCK HYDRO INC.	SHOSHONE II	800
		Total (kw)	1,170

Source:
Operating Facilities by Technology in the State of Idaho, Renewable Electric
Plant Information System, National Renewable Energy Laboratory (Data updated to 2004)
http://www.eere.energy.gov/state_energy/opfacbytech.cfm?state=ID#Hydro
(Water sources and locations were provided by Brockway Engineering)

Hamilton
Water Economics

Economic Importance of ESRPA-Dependant Springflow

Figure A - 1: Bannock County Percent of Irrigated Acres

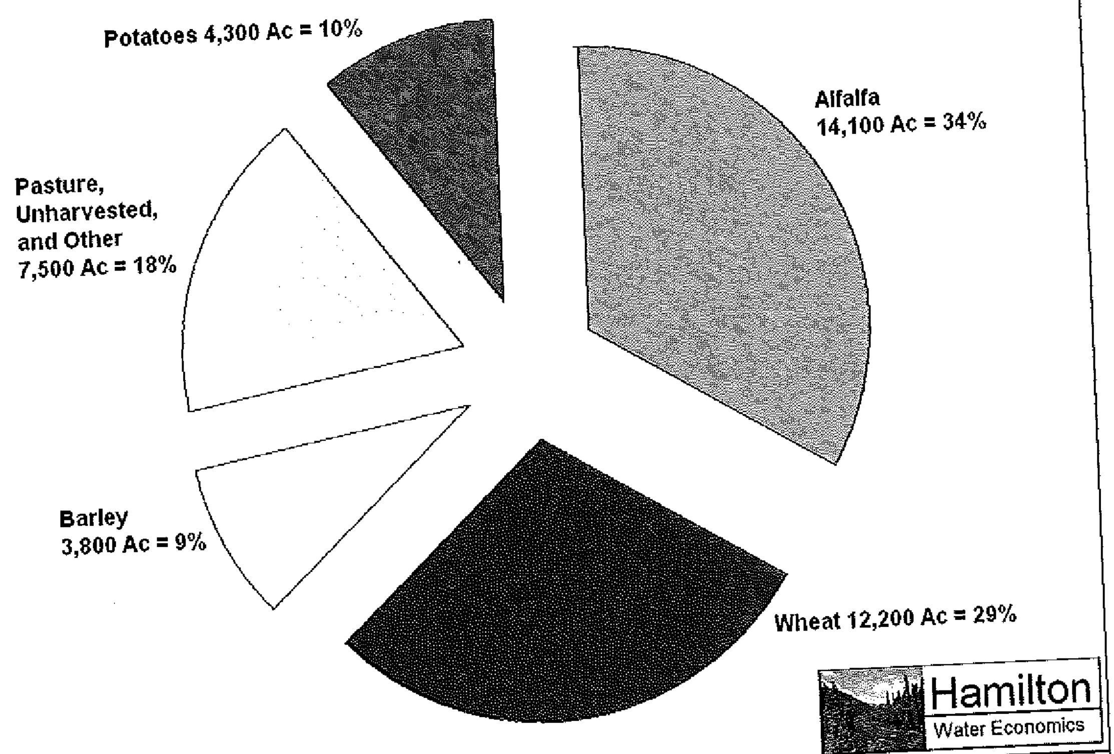
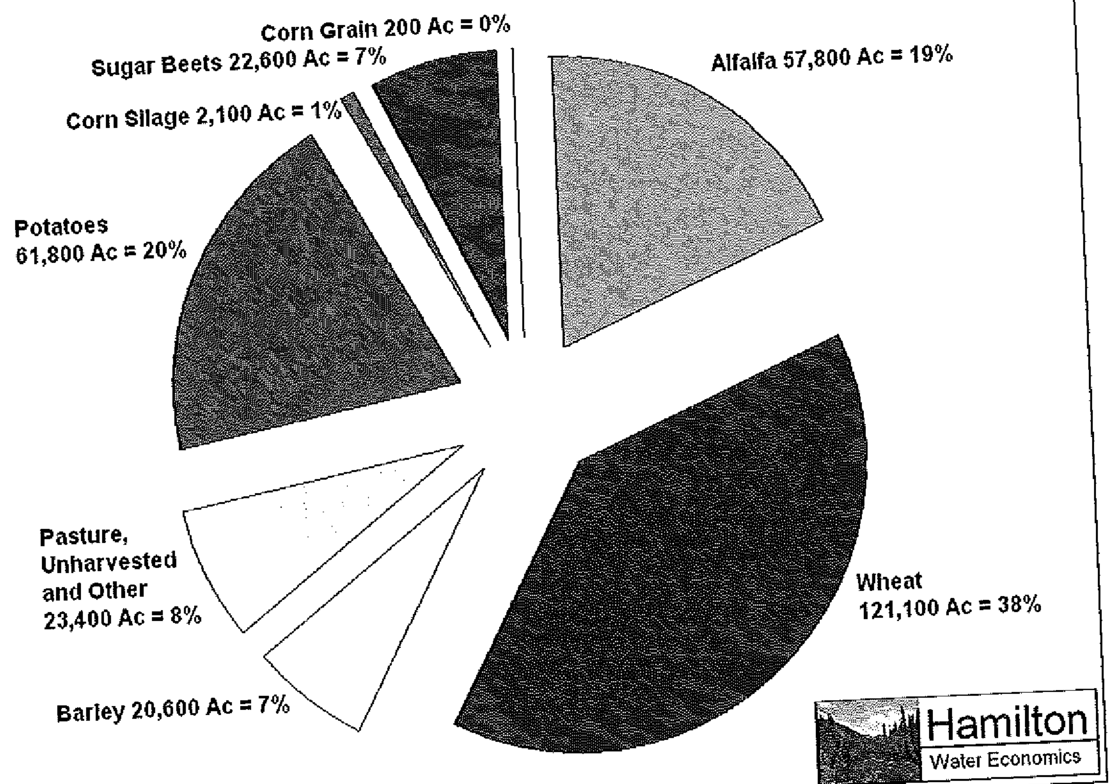


Figure A - 2: Bingham County Percent of Irrigated Acres



Economic Importance of ESRPA-Dependant Springflow

Figure A - 3: **Blaine County Percent of Irrigated Acres**

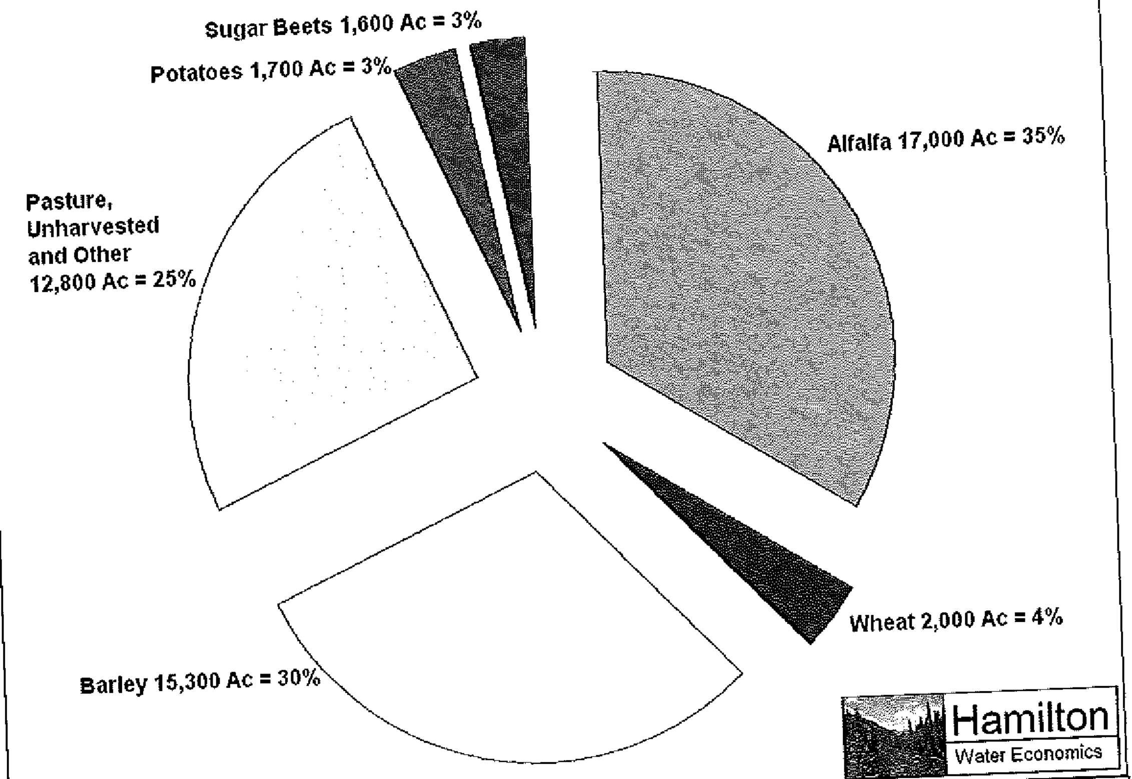
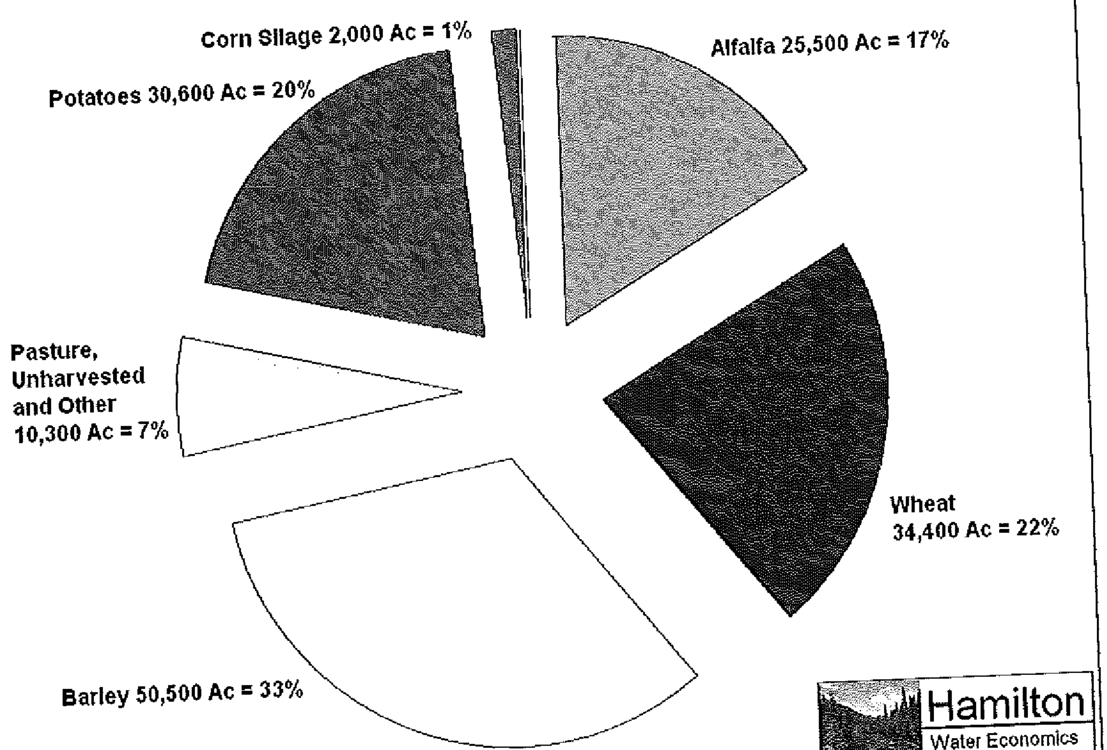


Figure A - 4: **Bonneville County Percent of Irrigated Acres**



Economic Importance of ESRPA-Dependant Springflow

Figure A - 5: Cassia County Percent of Irrigated Acres

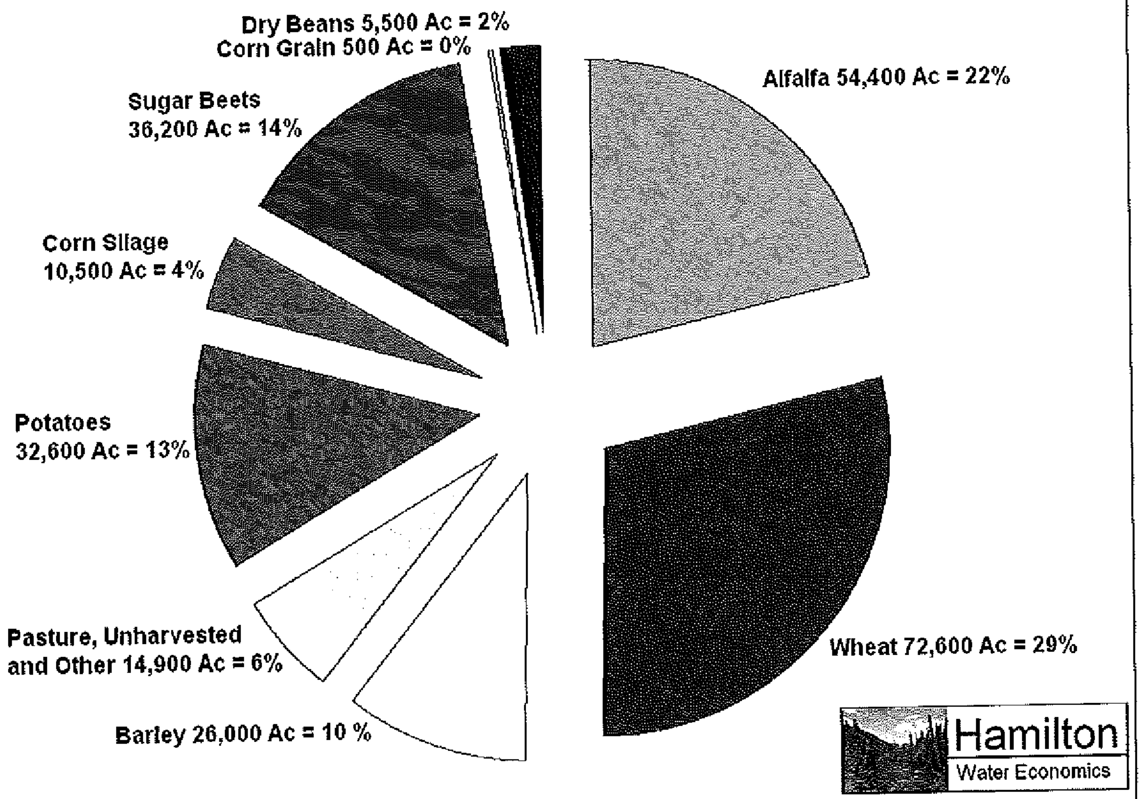
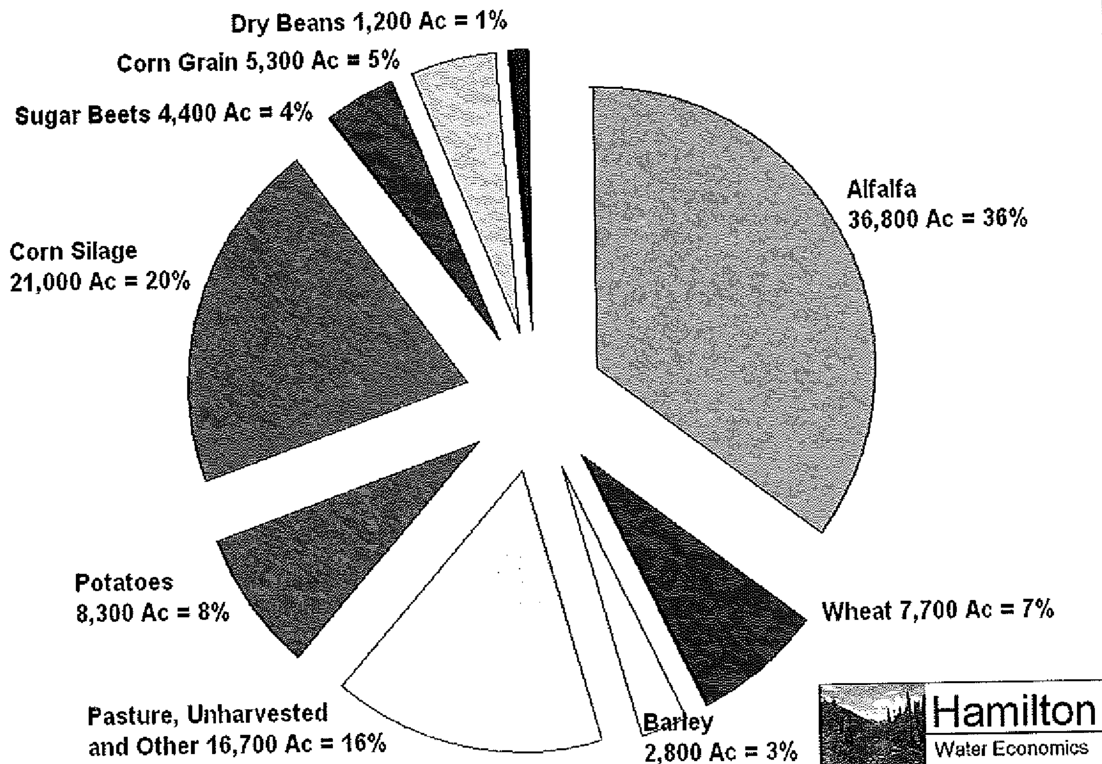


Figure A - 6: Gooding County Percent of Irrigated Acres



Economic Importance of ESRPA-Dependant Springflow

Figure A - 7: **Jefferson County Percent of Irrigated Acres**

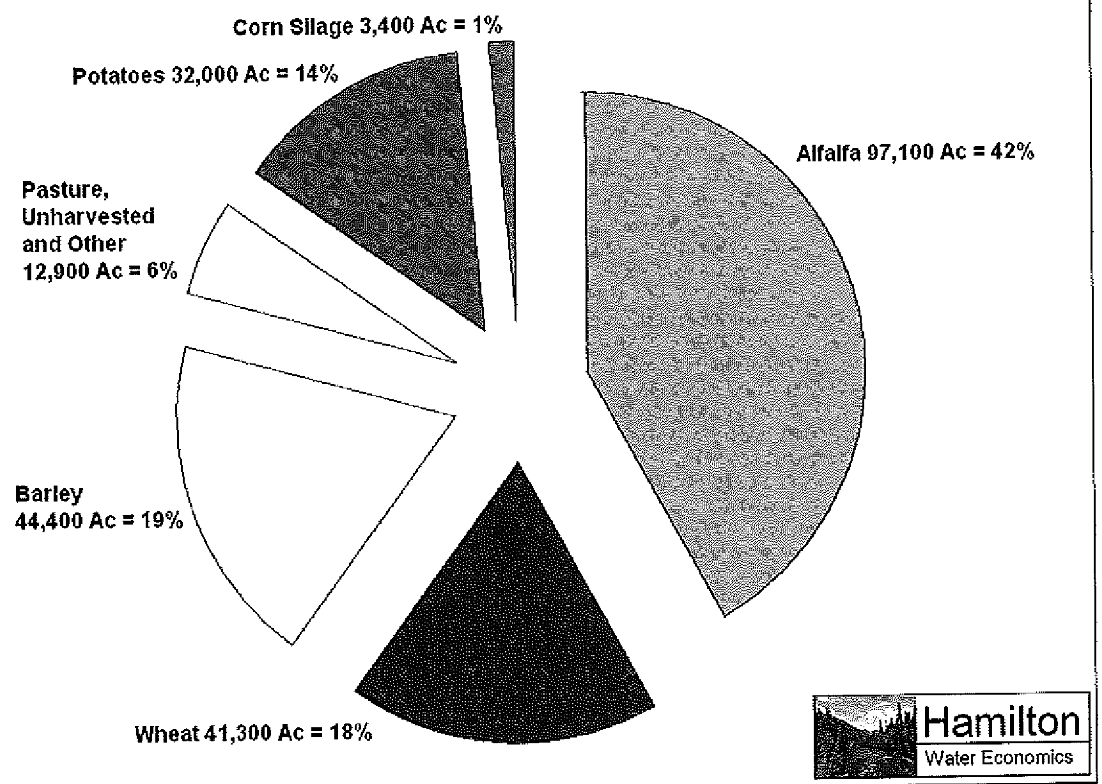
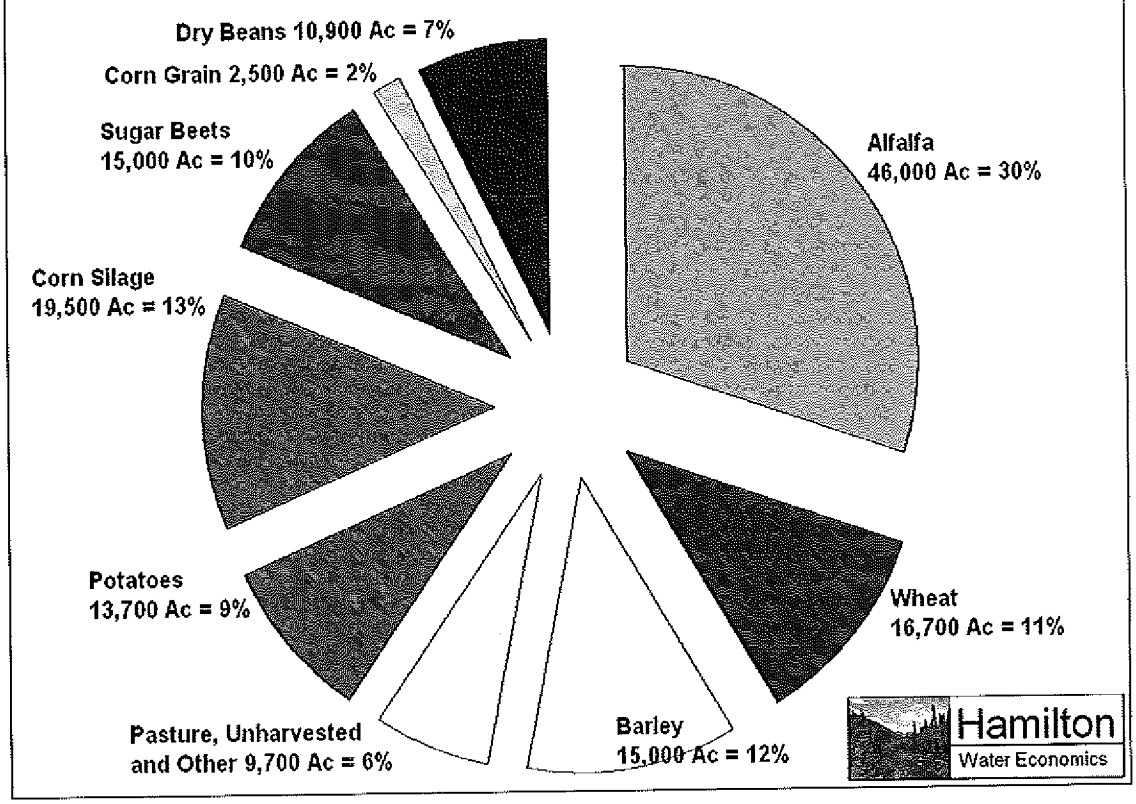


Figure A - 8: **Jerome County Percent of Irrigated Acres**



Economic Importance of ESRPA-Dependant Springflow

Figure A - 9: Lincoln County Percent of Irrigated Acres

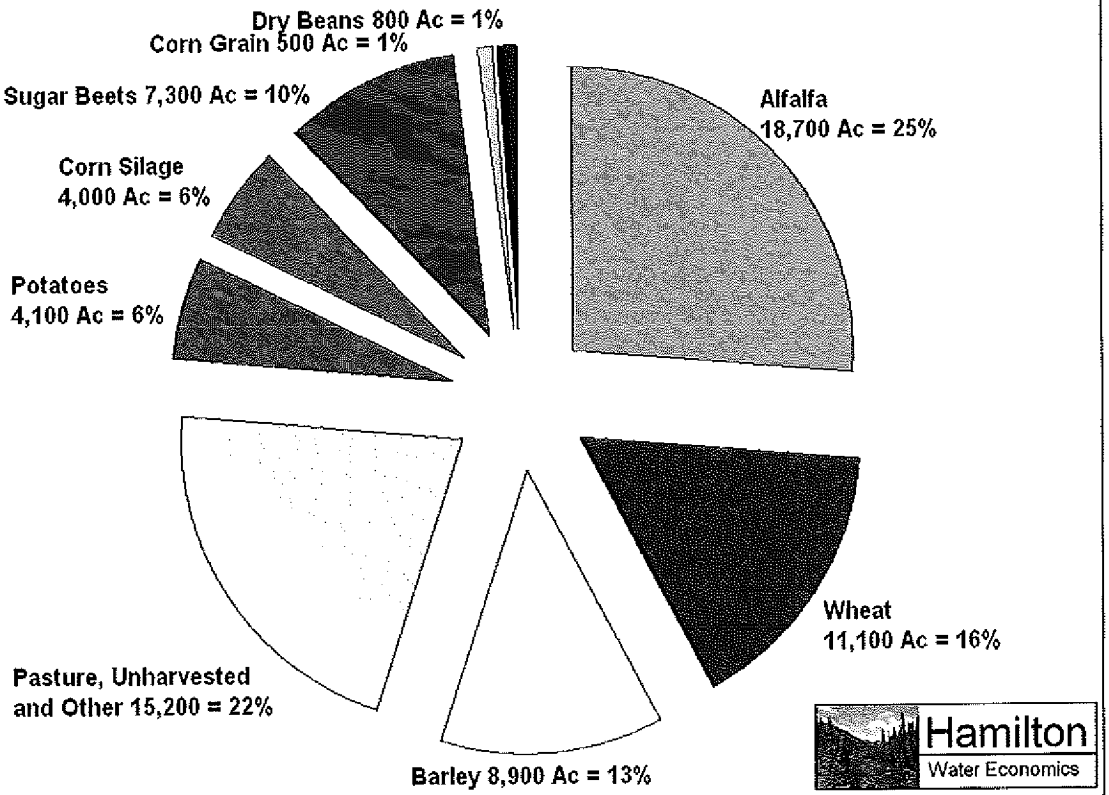
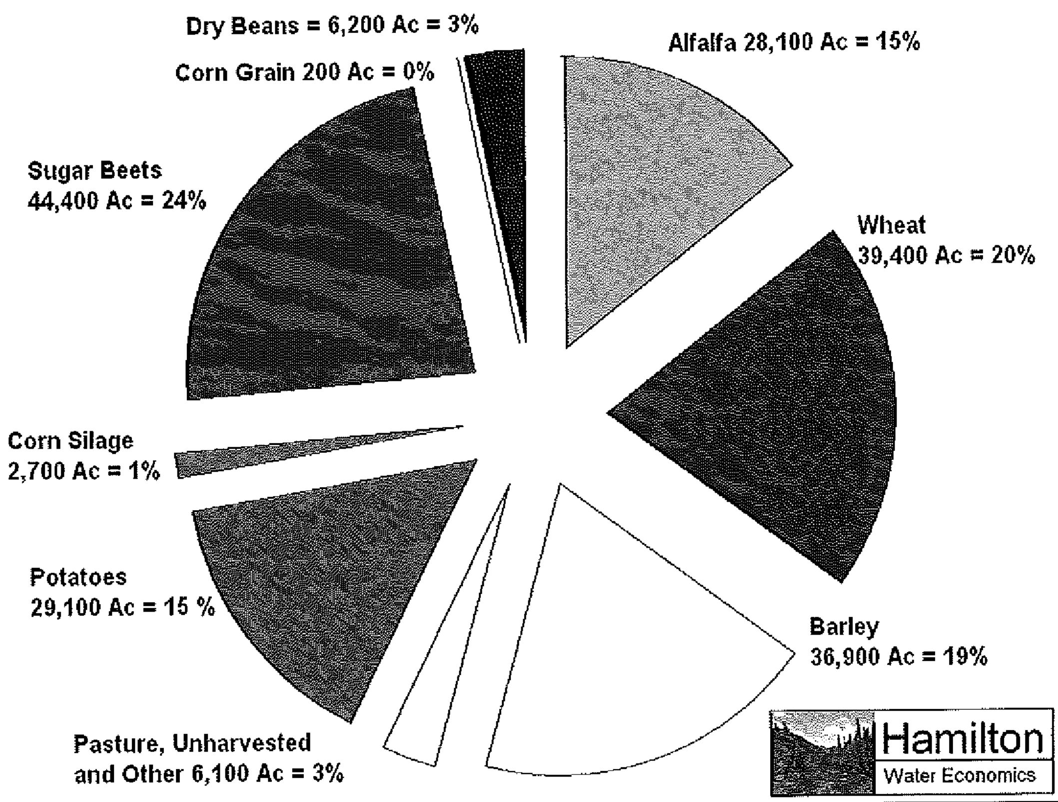


Figure A - 10: Minidoka County Percent of Irrigated Acres



Economic Importance of ESRPA-Dependant Springflow

Figure A - 11: Power County Percent of Irrigated Acres

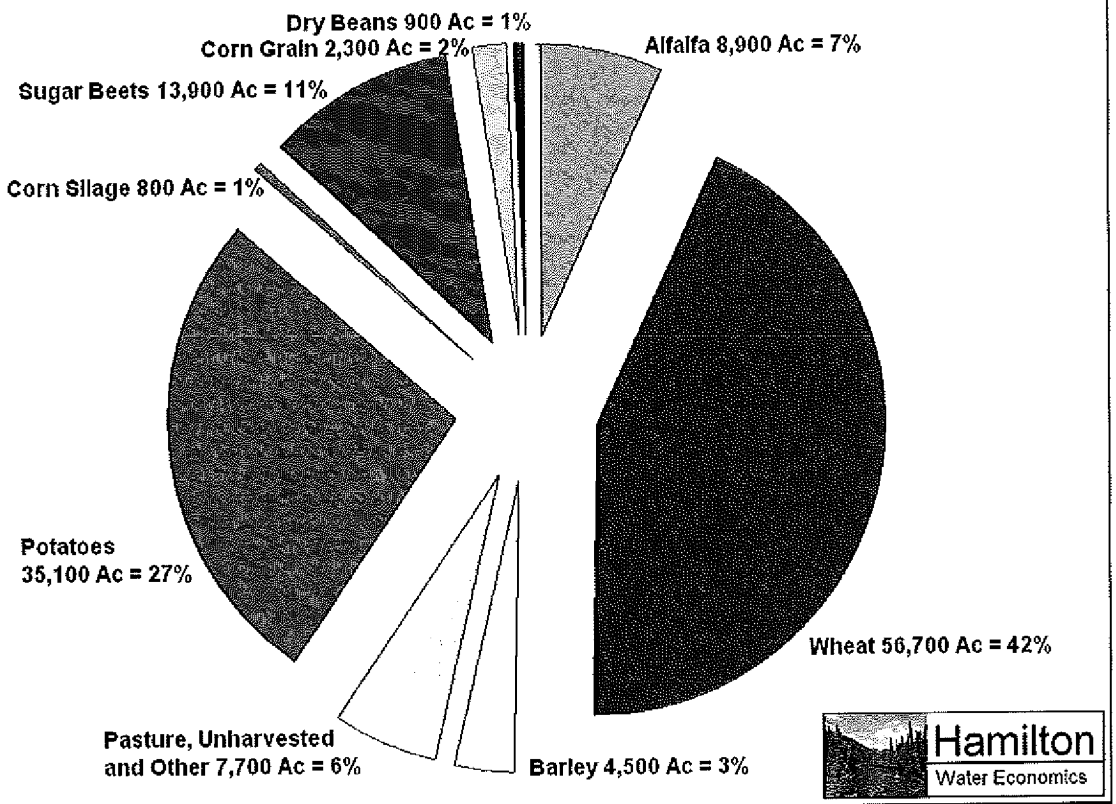


Figure A - 12: Twin Falls County Percent of Irrigated Acres